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[SECOND SERIES.]

Art. XVII.—*A Sketch of the History of Conchology in the United States.**

The history of Conchology in America is necessarily brief—yet it is adorned with names which compare favorably with those of any of its cultivators in the old world. Indeed, wherever Conchology is studied, the works of Say, Lea, Conrad, the Binneys, Adams, Gould, and numerous other of our authors, are referred to as standard authorities. With so much perseverance and skill have our Conchologists worked up certain genera of shells, that almost all new species in those genera, are placed in their hands for determination and description.

In the earlier years of our scientific history there were almost no libraries, authentically named specimens, or well informed naturalists in America; hence the student was compelled to rely entirely upon himself; and his descriptions, published necessarily in an obscure manner, were inaccessible to, or generally neglected, or entirely unnoticed by Europeans, who continually redescribed the same species under different names, without regard to the prior claims of American authors, and frequently without the slightest attempt to study out their writings.† It was during these years of neglect that the science of Conchology was first cultivated in this country. Its votaries were men whose whole

* List of American writers on Recent Conchology. With the Titles of their Memoirs and dates of publication. By George W. Tryon, Jr., Member of the Academy of Natural Sciences of Philadelphia. 8vo. 68 pp. Baillière; New York, London, Paris and Madrid. 1861.

† See the chapter "*Of the ignorance and neglect of American Labors in Zoology, exhibited by European Naturalists.*" Binney's Terrestrial Mollusks, i, p. 56.

hearts were in their work, and they were continually urged by a noble ambition to new discoveries and achievements.

It must be acknowledged that notwithstanding adverse circumstances, the field was inviting to our naturalists; they were working in a new world, a vast continent whose varied and prolific natural objects, scattered as they were, over the broad expanse, from the ice-bound confines of the polar sea to the tropical regions of South America, had rarely or never met the eyes of civilized man. The abundance of material to be worked up, must in itself have proved a great inducement to commence the study of Conchology; in which even at the present time, there is vastly more yet to be elucidated in the United States than in Europe.

C. A. Le Sueur, a native of France, who resided for some years in Philadelphia, where he published numerous papers on Ichthyology and other branches of Natural Science, is the author of the first article on Mollusca published in America. Mr. Le Sueur's paper, which was printed in the first number of the Journal of the Academy of Natural Sciences of Philadelphia (May, 1817), is entitled "Description of six new species of Firola, observed in the Mediterranean Sea by Messrs. Le Sueur and Péron in the months of March and April, 1809." It is illustrated. Mr. Le Sueur followed this at short intervals, with descriptions of various new species of Cephalopoda and Pteropoda, all in the same Journal.

Thomas Say. In the same number of the Journal of the Academy which contains Le Sueur's first paper, and of equal date with it, is the first conchological paper by Say, the greatest of our earlier naturalists—a man who, without the advantage of a liberal education or the means which have since been brought into the study of natural history, made for himself an undying reputation in almost every branch. With a quick eye for distinguishing differences, and a remarkably sound judgment of their proper values, most of his descriptions are models of accuracy combined with brevity. Very few of his species have been set aside. Mr. Say had also the merit of appending to most of his descriptions of species, their prominent distinctive characters from nearly allied forms—a very important part of a natural history description, too generally neglected. Mr. Say's principal writings on Conchology consist of—

1. Ten articles in the Journal of the Academy of Nat. Sciences, vols. i, ii, iv, and v, (1817–1826) describing a very large proportion of the marine shells of our Atlantic coast, a majority of the Helices of the Middle States, together with many from the South and West, and many fresh water species.

2. Article "Conchology" in Nicholson's Encyclopedia, American editions. Published also separately, with the title "Descriptions of the land and fresh water shells of the United States." Philadelphia, 1818.

3. Numerous descriptions of terrestrial and fluviatile shells in the "Disseminator," a weekly paper published at New Harmony, Ind., (1829–1831). These were subsequently issued in pamphlet. New Harmony, Ind. pp. 26. 1841.

4. A short paper in the Transylvania Journal of Medicine. Lexington, Ky., 1832, (included in the last named pamphlet).

5. An Appendix to the Narrative of Long's Expedition to Lake Winnepeg, containing descriptions of Mollusca, &c.; published in 1824.

6. American Conchology; or "Descriptions of the Shells of North America." Issued in 6 numbers, 8vo, with sixty colored plates. New Harmony, Ind., 1830–4. A 7th (posthumous) number has been published by Mrs. Say.

The "American Conchology" contains a large number of our common Mollusca, of which very many are either nowhere else figured, or only in expensive monographs. The descriptions are very full and accurate, and the plates characteristic, though not well finished.

In the above publications Mr. Say has introduced one hundred marine, one hundred fluviatile, and seventy-five terrestrial species. A large number of types of these, labelled by the author, are preserved in the Collection of the Academy of Nat. Sciences at Philadelphia.

The demand for the "American Conchology," and other papers long out of print, had become so great, as to induce, in 1858, their republication, with colored plates, as the "Complete writings of Thomas Say, on the Conchology of the United States." This work is ably edited by Wm. G. Binney, who has revised the nomenclature of the genera and species, and added many valuable notes.

C. S. Rafinesque, added to his other attainments in Natural Science, a considerable knowledge of Conchology; and he pursued its study with great ardor after his arrival in this country. Unfortunately, his earlier descriptions are too short and indefinite, and nearly all of his figures are too rude, for satisfactory recognition; later, his love of fame and insatiable species-mongry induced him to mingle these with descriptions of objects which never existed; and finally, we are compelled to believe, that he put full confidence himself in the existence of these imaginary objects, as the dark cloud settled on his mind, which made him in fact a mad naturalist. During this period Rafinesque frequently redescribed his own species under different names, and ignored entirely the works of other American naturalists, appropriating their species with an audacity which can only be excused by charitably conceding his mental aberration.

Under these perplexing circumstances, most of our Conchologists, after vainly endeavoring to identify his descriptions, have discarded them almost entirely. The following are Mr. Rafinesque's principal publications, referring to our Mollusca:

"Discoveries in Natural History made during a Journey through the Western Region of the United States." Published in the American Monthly Magazine and Critical Review, vols. iii and iv. New York, 1818–19.

"Prodrome de 70 nouveaux Genres d'Animaux d'Amerique, durant l'Annèe, 1818." In the *Journal de Physique*, Paris, Juin, 1819.

"Monographie des Coquilles Bivalves Fluviatiles de la Rivière Ohio, contenant douze Genres et soixante huit Espèces." In *Annales Générales des Sc. Physiques*, Tome iii. Bruxelles, Sept. 1820.

C. A. POULSON, of Philadelphia, in 1832, translated this last paper of Rafinesque's and published it in a small volume entitled:

"Monograph of the bivalve fluviatile Shells of the River Ohio."

D. H. BARNES was the next American writer on Shells. He published in this Journal ([1], vi, No. 1, 1823,) an important paper "On the genera Unio and Alasmodonta, with introductory remarks." This article, which contains descriptions of several supposed new species, bears evidence of considerable knowledge of the Naiades. Some of his species were, however, anticipated by Lamarck, who became early acquainted with a number of our Uniones.

In vol. xiii, of this Journal, Mr. Barnes made a reclamation of his species of Naiades. He also contributed a paper describing five new species of Chiton in vol. vii, No. 1. 1824. Mr. Barnes was one of the earliest contributors to the "Annals" of the New York Lyceum of Natural History, of which Society he was an efficient member. He published three papers in the first and second volumes of the Annals, 1824–28. He was accidentally killed, Oct. 27, 1828.

Dr. JACOB GREEN (deceased) was one of the earliest workers in this department of Natural Science. The following papers by Dr. Green are in the Contributions to the Maclurian Lyceum:

1. "Description of Helix Pennsylvanicus." *Note* to a Memoir on Salamander, p. 8. Read Oct. 23, 1826.
2. "Some Remarks on the Unios of the United States." Read April 23, 1827.
3. "Description of two new species of Achatina from the Sandwich Islands." Read May 14, 1827.
4. "Remarks on Achatina Stewartii." Read Sept. 27, 1828.

His papers in the Transactions of the Albany Institute consist of—

1. "Monograph of the Cones of North America, including three new species."
2. "The Dolia of the United States," and
3. "Notes on American Shells figured in the Supplement to the Index Testaceologicus." All read June 7, 1830.

He also contributed papers at various times to Doughty's Cabinet of Natural History. Vols. i, ii, iii. Philadelphia, 1830–33.

Dr. S. P. HILDRETH, of Marietta, Ohio, a well known contributor in other departments to this Journal, published in the first series, vol. xiv, 1828, an interesting paper on the shells inhabiting the vicinity of that town.

ISAAC LEA, President of the Academy of Natural Sciences, contributed his first paper on Conchology to the Philadelphia Philosophical Transactions, vol. iii, 1828; and from that date to the present time, a period of thirty-four years, he has given unceasing attention to the science, and particularly to his chosen speciality, the Naiades, with whose history he has become perfectly identified, having described five-sixths of all the recent species published.

There are but few authors who have so patiently, indefatigably and successfully, worked up the subject of their studies as Mr. Lea. He has contributed two hundred papers to the Proceedings of the Academy, and of the Philosophical Society, describing about 550 species of Naiades, 400 species of Melanians and other fresh water shells, and 50 species of Terrestrial shells.

These papers are elaborated in the Transactions of the Philosophical Society, and Journal of the Academy of Natural Sciences, 2d series, and are illustrated by excellent figures, many of them colored.

They have also been issued in *eight quarto volumes*, containing in all 850 pp. and 198 plates, as follows:

Vol. I.	1832, pp. 230.	From Philos. Trans.	III, IV, V.
" II.	1838, pp. 152.	" " "	VI.
" III.	1842, pp. 88.	" " "	VIII.
" IV.	1845, pp. 75.	" " "	IX, X.
" V.	1852, pp. 62.	" " "	X.
" VI.	1858, pp. 96.	From Trans. Acad. Nat. Sci.	III, IV.
" VII.	1859, pp. 90.	" " " "	IV.
" VIII. (Part I.)	1860, pp. 56.	" " " "	IV.

Mr. Lea has also published three editions of his "Synopsis of the Family of Naiades," a work containing a list of the species and their synonymy; the shells being grouped according to obvious external characters, in order to facilitate their determination. There is also a table of geographical distribution, and a very full index and bibliography of the subject; making the book an indispensable aid to those studying this interesting family of shells.

The third edition of the Synopsis was issued in 1852. (4to, pp. 88.) Since that time many new species of Naiades have been described, rendering a new edition necessary; and on this useful work, Mr. Lea is now engaged.

He has also attentively studied the Melanians of America, besides describing many exotic species for the Zoological Proceedings, London, 1850.

His last paper in the Proceedings of the Academy contains diagnoses of forty-nine new species of these shells, from Alabama. Mr. Lea is still actively engaged in his favorite pursuits, and we may expect many able papers yet from his hands. We hope that he will find leisure to monograph the Naiades, with the same fulness of description and excellence of illustration, which distinguishes Binney's Terrestrial Mollusks. Such a work would be the crowning glory of a life nobly and usefully spent in the pursuit of science.

T. A. CONRAD, the eminent geologist, in the same year in which Mr. Lea printed his first article on the Naiades, gave to the world through the Journal of the Philadelphia Academy, (1st ser., vol. vi, p. 205 : Aug. 1830,) an article on the Geology of Maryland, containing a list of recent shells of the coast of that State. This was followed, all through the first series of the same Journal by papers on recent and fossil mollusca. The most important of these is one containing "Descriptions of new Marine Shells from Upper California," vol. vii; 1837. This article gives descriptions and figures of eighty species. In the *second series* of that Journal are several papers, by this author, on marine and fluviatile mollusca. Several of them are beautifully illustrated. A noticeable article is the "Monograph of the genus Argonauta, with descriptions of five new species;" vol. ii, p. 331: 1854.

Mr. Conrad has also contributed to this Journal for a period of over twenty years, and to the Proceedings of the Academy of Natural Sciences. His most important paper in the Proceedings is an able "Synopsis of the Family of Naiades of North America." Unfortunately, the author, with a sincere desire to do justice to Rafinesque, has preferred the doubtful identification of many of his obscure species, to the well characterized descriptions of Lea and others; thus placing as synonyms specific names which will always stand good among the majority of Conchologists.

Mr. Conrad also did an unintentional injustice to Mr. Lea, by a want of care in affixing dates of publication to several species. The errors in these dates were however corrected by Mr. Lea, a short time afterwards, in the Proceedings of the Academy for the same year. On the other hand, the "Synopsis" establishes the priority of Mr. Conrad's description of several southern species of Naiades, over those of Mr. Lea. It is worthy of remark, that Say, Conrad, and Dr. Jay, each of whom retain a number of Rafinesque's names, and who by long study of this family should be considered competent to make a final determination of the validity of his species, have differed greatly in their conclusions. Messrs. Say and Conrad have several times changed their opinion of the species *intended* by Rafinesque's descriptions. Rafinesque deposited in the cabinet of his friend, C. A. Poulson, Esq., of Philadelphia, a collection of Naiades, and named them;

but this was years after the publication of his papers, and meanwhile he had evidently forgotten many of the characters of his own species; those who have worked most ardently in his cause, are therefore compelled to declare that they are unable to reconcile some of his descriptions with Mr. Poulson's shells bearing the same names.

Mr. Conrad has described the shells collected by Lieut. Lynch's Dead Sea Expedition, and he also edited Part 7th (posthumous) of Say's American Conchology.

We have purposely left till the last, in order to bring them together, Mr. Conrad's most important publications—three of the most useful volumes on Conchology issued in America. They are all out of print, and are highly valued by those fortunate enough to possess copies. They consist of—

1. "American Marine Conchology." Philadelphia, 1831. 17 colored plates. 8vo, pp. 72.

This volume contains descriptions and figures of many of our common coast shells. The species, however, are different from those contained in the "American Conchology" of Thomas Say.

2. "New fresh water shells of the United States, with colored illustrations, and a monograph of the genus Anculotus, *Say*. Also, a Synopsis of the North American Naiades." 16mo, pp. 76. Philad. 1834.

This little volume contains descriptions of many new species of Uniones and Melanians collected by the author, in the Alabama River, &c. The book is poorly printed and illustrated, but its contents are very valuable.

3. "Monograph of the Family Unionidæ, or Naiades of Lamarck, of North America." Issued in 12 8vo numbers, 1835–38, and illustrated by colored plates.

This is Mr. Conrad's most elaborate work. Its great value consists in its illustrations of our most common and best known species, but which are nowhere else figured in American publications. Mr. Conrad may be considered, next to Lea, the best informed of living men, on our Uniones. Although he early chose Geology as his life-time study, he has nevertheless made for himself a reputation in recent Conchology.

Mr. Conrad's descriptions, unfortunately, are generally quite too brief, and bear evidence in many instances of haste or carelessness in their composition; being sometimes so devoid of characters, that the species would be totally unrecognizable were it not for the accompanying plates.

Amos Binney. While Lea and Conrad worthily succeeded Say, in the investigation of the American Uniones, the late Dr. Amos Binney, of Boston, continued the labors of our first great zoologist among the Terrestrial Gasteropoda of this country. To the study of these interesting shells he devoted the leisure moments of his active life, for many years; and in his "Terres-

trial Mollusks of the United States," he has left us a noble monument of his love of the science.

Dr. Binney became early identified with the progress of Conchological science in America; he was one of the founders of the Boston Society of Natural History, and became its president. He traveled much, in the cause of science, and made large collections; and being a man of wealth, he employed much of his means in the accumulation of a library on Conchology, which, at the time of his death, was unequalled in America.

Dr. Binney was not only a student, but a passionate lover of nature, and his more elaborate papers show that he possessed a genuine love of his subject, which carried him much farther than the mere details of scientific description, into the investigation of the habits and mode of life of the Terrestrial Mollusca.

Dr. Binney's published papers consist of five articles in the Proceedings, and five in the Journal of the Boston Society of Nat. History. The most important of these is, "A monograph of the Helices inhabiting the United States." This elaborate and excellently illustrated paper appeared in several successive numbers of that Journal, and was afterwards expanded into a separate work, entitled "The Terrestrial air-breathing Mollusks of the United States," &c. This work occupied several years of its author's life, in its preparation, and dying before its completion, his will was found to contain liberal provisions for the continuation and publication of the work in expensive and magnificent style. At the request of the executors, Dr. A. A. Gould assumed and excellently fulfilled the task of arranging the material, completing the descriptions, and editing the work; which was soon completed so far as to permit the publication of the two volumes of text, in 1851; but so many delays occurred in the production of the magnificent plates, that the third volume did not appear until 1859. The large sum of ten thousand dollars was expended on the four hundred copies issued of this splendid work, which were *given away*, an offering for science; all the prominent Conchologists and scientific libraries here and in Europe receiving copies. They are the best epitaph of their lamented author, and will keep his memory green in the hearts of men, long after the storied marble shall have crumbled to the earth.

At Dr. Binney's death, his collection of Terrestrial Mollusks, and library, came into the possession of his son, W. G. Binney, who has happily inherited and well sustains his father's love for their study.

Joseph G. Totten, Gen. U. S. Top. Engineers, is one of the oldest cultivators of the science. Many years ago, he made himself acquainted with the marine Mollusca of the New England States, and was one of the first to dredge and describe new species from that region. He contributed two papers to this Journal, [1], xxvi and xxviii, 1834–5.

J. P. COUTHUOY, a Conchologist of considerable reputation, described a large number of our shells, principally marine, in the Boston Journal and in this Journal, 1838–9. He accompanied Wilkes' Exploring Expedition, as Conchologist, collecting large numbers of Molluscous animals and their shells. Many of the species contained in Dr. Gould's Mollusca of the Expedition, are described by him.

JOHN CLARKSON JAY, M.D., of Mamaroneck, Westchester Co., N. Y., has amassed a very large and valuable collection of shells; of which he has published several catalogues. The first edition was issued in 1835; second edition in 1836, with descriptions of new shells; third edition, 4to, 1839, with descriptions of new shells—illustrated with ten colored plates; fourth edition, 1850, 4to, containing 10,874 species, with a supplement (1852) containing 191 additional names.

These catalogues are arranged on the Lamarckian system. As all the synonyms are given besides the correct specific names, and references constantly made to figures and descriptions, this catalogue, (4th edit.) embracing as it does, so large a proportion of all the known species of shells, is invaluable as a work of reference, or as a guide to the formation of cabinets, and the exchange or cataloguing of specimens. The amount of labor on the last edition of this work must have been immense; the list extending to 480 pages and embracing 40,000 names, including synonyms; each accompanied by a reference to a figure and description. This could not be accomplished without years of preparatory study, and a familiar knowledge of all existing authorities on the subject.

Exception has been frequently taken to portions of Dr. Jay's Synonymy. To expect perfection throughout so extensive a subject, would be to look for impossibilities—but Dr. Jay has certainly a claim to be heard in this matter. With a magnificent collection of authentic specimens, embracing in many cases numerous varieties, and possessing, besides, a very complete library of works on Conchology, his deliberate conclusions certainly should have great weight among naturalists.

J. P. KIRTLAND, M.D., of Ohio, a zealous naturalist, has given considerable attention to the study of the Mollusca of his State. Various articles from his pen, relating to the Naiades, &c., are contained in this Journal for 1834, '37, '40.

Dr. Kirtland also gives a list of shells, in his Zoological Report of the State of Ohio. His latest publication on Conchology is a paper read before the American Association for the Advancement of Science, in 1851, and published in their Proceedings for that year. It is entitled, "Remarks on the sexes and habits of some of the acephalous Bivalve Mollusca."

CHARLES B. ADAMS (deceased 1851) was one of the most indefatigable and accurate of our Conchologists. His published papers, in thirteen years, amounted to about sixty, containing descriptions of 700 species of shells.

Of these articles, nine were printed in this Journal, six in the Boston Proceedings and Journal, four in the Proceedings of the American Association, and nine in the New York Lyceum Annals. The most important are—

"Descriptions of new species of shells." This Journal, [1], vol. xxxix, 1840.

"Catalogue of the Mollusca of Middlebury, Vt., and vicinity; with observations." This Journal, vol. xl, 1841.

"Description of twenty-five new species of New England shells." Bost. Proc., ii, 1844–5. This was written in conjunction with Dr. Mighels.

"Specierum Novarum Conchyliorum in Jamaica repertorum, Synopsis." Bost. Proc., ii, Jan. 1, 1845.

"Descriptions of new species of marine shells of New England." Bost. Journ., ii, 1840.

"On the nature and origin of the species of Testaceous Mollusca in the Island of Jamaica." Proc. American Assoc., iv, 1851.

Descriptions of a great number of Jamaica Shells, in the Lyceum Annals, 1850–1.

"Catalogue of shells collected at Panama." Annals Lyceum, 1852; also published separately in a thick 8vo volume.

"Mollusca," in Thompson's History of Vermont; also issued in a pamphlet, 20 pp.

Two small quarto tracts containing monographs of the genera Stoastoma and Vitrinella.

"Contributions to Conchology." 8vo, 258 pp. Issued in twelve numbers, from 1849 to 1852.

The study of the Mollusca of Jamaica occupied Prof. Adams' principal attention, and he was eminently successful in his researches among them.

Prof. Adams described numerous new species among the shells collected by him at Panama. The number of Jamaica shells that he has described is also very large—namely, 260 terrestrial, 20 fluviatile, and 200 marine species.

Prof. Adams also gave much attention to the habits and geographical distribution of these shells, and has illustrated the subject in several able papers. The large collections made by Prof. Adams at Panama and Jamaica, were properly named, and a full series placed in the Cabinet at Amherst College; the remainder were offered for sale by the trustees of the College, on whose account he visited those regions. A very large number of specimens were thus distributed among the lovers of the science in America and Europe, so that many private cabinets contain good collections of them.

The descriptions, of this author, are very minutely accurate, dwelling on every slight peculiarity of the shell before him; hence, a number of his species have proved to be merely well marked varieties, undue importance being attached to all their minor differences.

The writings of Prof. Adams are, however, very valuable, as they are distinguished by their marked ability, and fill up a gap in the history of American Mollusca; no other author having described any considerable number of the shells of Jamaica—an island which contains an almost isolated molluscous fauna—very few only of its species being common to the other islands.

AUGUSTUS A. GOULD, M.D., of Boston, is one of our most voluminous writers on Conchology, his papers covering almost the entire range of the science.

His first publication was a translation of the generic descriptions by Lamarck, entitled, "Lamarck's Genera of Shells; with a catalogue of species." (Boston, 1833.) He has since that time had the good fortune to be connected with some of the most elaborate works on the subject, published in America.

Dr. Gould contributed several short papers to this Journal, in 1840 and 1848; and he has also a paper in the London Zoological Proceedings for 1857, "On the Nautilus umbilicatus of Lister." With these exceptions, the whole of his shorter papers have appeared in the Boston Journal and Proceedings. The Journal contains:—

"A monograph of the species of Pupa found in the United States."

"Descriptions of shells from the Gulf of California, and the Pacific Coasts of Mexico and California."

Also, articles describing shells from Burmah, Cuba, and Africa.

The contributions of Dr. Gould to the Boston Proceedings number over forty, and embrace descriptions of terrestrial, fluviatile and marine species from all parts of the United States, Burmah, Liberia, Sandwich Islands and Brazil; those of Wilkes' U. S. Exploring Expedition, and the North Pacific Exploring Expedition. Besides these, Dr. Gould's "Remarks" made before the Boston Society, and published in their Proceedings, embrace a running commentary on recent publications, criticisms of new species, details of the habits and anatomy of the Mollusca, and many other interesting subjects.

The paper "On the shells collected by Wilkes' U. S. Exploring Expedition," contains short descriptions of the hundreds of species which have since been published in complete and beautiful style, as a Government Report.

The plates of this Report have just been issued, their preparation having occupied several years. They are very carefully drawn and splendidly colored.

Dr. Gould has been lately engaged on the Mollusca of the North Pacific Expedition—short diagnoses of species appearing in the numbers of the Boston Proceedings, to be followed at some future time by the publication of an elaborate Government Report.

When the State of Massachusetts added a Zoological Department to their Geological Survey, to Dr. Gould fortunately was assigned the Invertebrata of the State, comprising the Mollusca, Annelida, and Radiata. The result of his investigations appeared in a thick octavo volume published in 1841. This work is distinguished for the critical accuracy of its descriptions, and has become a standard authority on our marine shells, of which it describes many new species. While it is the first work embodying the complete molluscous fauna of any portion of our country, it still remains the *best.*

Dr. Gould was chosen by the executors of the will of Dr. Amos Binney, to edit the work on the "Terrestrial Mollusks," which was left incomplete by the death of that author. This labor he performed with great skill and judgment. The illustrations were continued in the same magnificent style as they were commenced under the direction of Dr. Binney, and the literary contents are augmented by descriptions of many new species discovered prior to the publication of the third volume, at the commencement of which they are inserted. Dr. Gould has also contributed to the first volume, a valuable memoir of Dr. Binney. Dr. Gould is an accurate and critical observer and describer of natural objects. His pages exhibit to the eye the individuality of his subject with the same clear analytical precision with which it impressed his own mind. He has been very successful in his investigations, adding nearly one thousand species to the recent Mollusca.

JOHN G. ANTHONY, of Cincinnati, has for years devoted his attention to the study of the Melanians of the United States; and he has divided with Mr. Lea the honor of working up the many species of this interesting family.

Mr. Anthony's principal papers are, one in the Boston Proceedings, vol. iii, describing sixteen species of Melania, one in the New York Lyceum Annals, vol. vi, April 1854, describing fifty species collected by himself in the Southern States, and another in the Proceedings of the Philadelphia Academy, Feb. 1860, describing fifty-eight species.

S. S. HALDEMAN. Our fluviatile Gasteropoda, other than Melanian, are best known through Prof. Haldeman's "Monograph of the Limniades, and other fresh water univalve shells of North America," published in eight numbers—1840–44. The descriptions of species in this work are very full, and admirably illustrated by the colored plates.

Prof. Haldeman has published in Chenu's "Illustrations Conchyliogiques," a "Monographie du genre Leptoxis, Rafinesque; (Anculosa, Say.)" Folio, Paris, 1847, with beautiful plates. He has also contributed several papers to the scientific Journals, among which is an "Enumeration of the Recent Fresh-water Mollusca which are common to North America and Europe, with observations on species and their distribution," in the Boston Journal, iv, p. 468, 1844. This paper, together with the comparisons instituted by Prof. Adams with our marine species, and by Dr. Binney in the terrestrial shells, has furnished much valuable information in regard to the geographical range of species over parts of two continents.

HENRY C. LEA, son of Isaac Lea, has evinced considerable talent in the sciences of Conchology and Geology. He has a short paper in the first series of this Journal; and a more extensive one in the Boston Journal, entitled "Descriptions of some new species of marine shells inhabiting the coast of the United States." He also assisted his father in the determination and description of the exotic Melanians in the collection of Mr. Cuming.

CHARLES M. WHEATLEY, M.A., of Phœnixville, Pa., who has formed an excellent private collection of shells (now the property of Union College), published, in 1842, the first general "Catalogue of the Shells of the United States, with their localities."

New species of shells from Maine are described by Dr. J. W. Mighels, in the Bost. Journal, iv, p. 37, January 1842.

These Catalogues are very useful in stimulating research, and also afford much information regarding the geographical distribution of species.

The following Catalogues have been published:

Maine. By Dr. Mighels.
Vermont. By Prof. C. B. Adams.
Massachusetts. By A. A. Gould, Gen. J. G. Totten, Samuel Tufts, W. Prescott, J. M. Earle, Thomas A. Greene, J. L. Russell, Wm. Stimpson, and Jos. True.
Connecticut. By Rev. J. H. Linsley and Dr. A. A. Gould.
New York. By Dr. J. E. DeKay, Sanderson Smith, and Dr. James Lewis.
Pennsylvania. By Prof. S. S. Haldeman, Wm. Hartman, R. M. S. Jackson and Wm. M. Gabb.
Maryland and Virginia. By T. A. Conrad and Charles Girard.
North and South Carolina. By J. D. Kurtz and Lewis R. Gibbes.
Florida. By T. A. Conrad.
Mississippi. By B. L. C. Wailes.
Louisiana. By Geo. C. Shumard and C. B. Adams.
Tennessee. By Gerard Troost.
Ohio. By Jno. G. Anthony, Frank Higgins, S. P. Hildreth, and J. P. Kirtland.

Indiana. By J. T. Plummer.
Illinois. By Robert Kennicott.
Michigan. By Dr. Abraham Sager.
Wisconsin. By I. A. Lapham.
Washington Territory. By Wm. Cooper.

Lists of the Terrestrial, Fluviatile and Marine Shells of the United States have been drawn up by Messrs. W. G. Binney, Temple Prime, Isaac Lea, P. P. Carpenter and Wm. Stimpson, and published by the Smithsonian Institution.

James E. DeKay, M.D. The Zoological Department of the New York Geological Survey was committed to Dr. DeKay, (deceased,) who in 1843 published a voluminous Report in quarto, on the Mollusca and Crustacea. The Mollusca comprise 277 pages with forty colored plates. This work has been carelessly compiled, and many of the species are almost unrecognizable from the descriptions. A number of new species are proposed, which would never have been brought forward, if Dr. DeKay had made himself as thoroughly acquainted with his subject as he should have done, before undertaking a work of such magnitude. Still, despite its numerous faults, this volume is necessarily an important addition to conchological literature. In nearly every genus, short descriptions of the extra-limital species are given, so that over six hundred species of American shells are contained in it. The plates are roughly executed, and poorly colored.

Wyman and Leidy. Our knowledge of the anatomy of our terrestrial Mollusca is due almost entirely to the labors of Drs. Jeffries Wyman and Joseph Leidy.

The former has published in the fourth volume of the Boston Journal, papers "On the Anatomy of *Tebennophorus Caroliniensis*," and "On the Anatomical Structure of *Glandina truncata*, of Say."

Dr. Leidy, of Philadelphia, has carefully investigated the anatomical structure of our Terrestrial Gasteropoda, and has published the results of his labors in the first volume of Binney's Mollusks and in pamphlet. This paper, the preparation of which must have cost immense study, is illustrated by some of the finest anatomical plates ever published in America.

For the last ten years Dr. Leidy has occasionally described new forms of American Marine and Fluviatile Polyzoa, (Bryozoa), and we understand that he is preparing a monograph of our fluviatile species.

Louis Agassiz has given some attention to the anatomy and embryology of our Mollusca. He has several short papers in the Boston Proceedings, 3d vol., and an important article on the Embryology of Ascidia in the second volume of Proceedings of the American Association for the Advancement of Science.

It is understood that a coming volume of Agassiz's "Contributions" will contain an elaborate account of the embryological

development and anatomy of the animals of the North American Naiades.

JOHN H. REDFIELD, late of New York, now of Philadelphia, has published in the Annals of the Lyceum, several papers on marine and terrestrial shells. Among them are descriptions of several new species of Marginella—of which genus Mr. Redfield has made an especial study.

WILLIAM STIMPSON, M.D., has become a familiar name to Conchologists from his extensive study of our Atlantic coast shells. He has, probably a profounder practical knowledge of our marine molluscous fauna, and their bathymetrical and geographical distribution than any other naturalist. Dr. Stimpson's principal work is entitled "Shells of New England—a revision of the Synonymy of the testaceous Mollusks of New England." 8vo. Boston, 1851. This work is intended to be a companion to Gould's Invertebrata of Massachusetts—the nomenclature of which is corrected in accordance with the present arrangement of the mollusca.

Dr. Stimpson has contributed several interesting papers to the Boston and Philadelphia Proceedings and to this Journal. The extensive dredging operations conducted by this naturalist are deserving of much praise: numerous portions of our coast have been explored by him; and recently while accompanying the North Pacific Exploring Expedition, as zoologist, he obtained in this way an exceedingly rich collection of marine shells from the Japanese and Arctic seas. These are now being described by Dr. Gould, in the Boston Proceedings.

TEMPLE PRIME, of New York, is our great authority on the family of Cyclades, having confined his attention almost entirely to them. Besides descriptions of new species, Mr. Prime has done much good service in working up the synonymy of the several genera whose history he has investigated.

He has published the following papers:

"Descriptions of new species of Cyrena and Corbicula," and "Synonymy of the Cyclades," in Proceedings of the Academy Nat. Sciences; "Descriptions of new species of Cyclas and Pisidium," a "Synonymy of Pisidium," and "Descriptions of two new species of the genus Batissa, with notes on that genus," in Annals N. Y. Lyceum.

Several descriptive papers and Synonymy of Cyrenella and Rangia, in the Boston Proceedings; "Monograph of the species of Pisidium found in the United States of North America," illustrated, in Boston Journal; and "Descriptions of new shells (Cyclades) from the collection of Hugh Cuming, Esq.," in the London Zoological Proceedings.

In these papers, Mr. Prime has increased the number of known species of Cyclades nearly one-half.

THOMAS BLAND, of New York, first became known to Conchologists as an efficient co-laborer with Prof. Adams, in the West

Indian Terrestrial Mollusca. He contributed several papers to the "Contributions to Conchology," cataloguing the species of St. Thomas, W. I., and New Granada. He has also an article in this Journal, Nov. 1852, entitled, "Facts and principles relating to the origin and Geographical Distribution of Mollusca."

Mr. Bland's most important papers are the "Remarks on certain species of North American Helicidæ, with descriptions of new species," of which two parts have appeared in the 6th and 7th volumes of the Lyceum Annals. The third part is now ready for publication. These papers form a valuable addition to our critical knowledge of the Helices of the United States. Mr. Bland has also just issued a paper (see p. 158, this vol.) on the Geographical distribution of the Genera and Species of Land Shells of the West Indies, which gives many curious and important facts in reference to the range of species. Mr. Bland is thoroughly familiar with these shells, and is perhaps better fitted to pursue this important line of investigation than any other conchologist.

Wesley Newcomb, M.D., formerly of Troy, N. Y., now of Oakland, California, during a residence at the Sandwich Islands, for many years, studied the beautiful terrestrial genus Achatinella. He has described a large number of species in the New York Lyceum Annals, the Boston Proceedings, and the London Zoological Proceedings. His papers in the latter are illustrated with fine colored plates.

The Achatinellæ have also been studied and described by Dr. Mighels, Prof. Adams, Dr. Gould, and Mr. Gulick.

The genus Argonauta has been studied by Dr. J. C. Parkinson, who has added two new species.—Bost. Proceed., Sept. 1856.

William A. Haines, of New York, the possessor of one of the finest private conchological collections in the world, has a paper in the New York Annals, vol. vi, Oct. 1855, describing several new species of terrestrial shells from Siam.

James Lewis, M.D., of Mohawk, N. Y., has industriously studied the Mollusks of that vicinity, making many valuable additions to our knowledge of the habits and mode of growth of many of the fluviatile species. His numerous brief papers are contained in the Boston and Philadelphia Proceedings.

J. B. Trask, M.D. The only papers on Conchology published as yet west of the Rocky Mountains, are two by Dr. Trask, describing new species of Naiades of California, published in the Proceedings of the California Academy of Nat. Sciences, vol. i, 1855; and Descriptions of Terrestrial and Fluviatile Shells, by Dr. Newcomb, in the Proceedings of the same Society for 1859 and 1860.

William G. Binney, of Burlington, N. J., has continued the investigation of the Terrestrial Shells, commenced by his father. He published in 1859, in the Boston Journal of Natural History,

and also separately, a "Supplement to the Terrestrial Mollusks," forming vol. iv of that work in 8vo, pp. 207, with six colored plates. This volume, which exhibits great ability and an intimate knowledge of his subject, placed its author at once in the foremost rank of American conchologists. It not only describes all the more recent species, but also includes a thorough revision of those contained in his father's work, giving additional synonymy and localities.

Mr. Binney has published a number of papers in the Proceedings of the Academy of Natural Sciences, 1857–61, under the general title of "Notes on American Land Shells." These papers contain descriptions of many new species, and a complete synonymy of our Helices. He has prepared for the Smithsonian Institution lists of the Terrestrial and Fluviatile Gasteropoda of North America. He also edited, recently, in an able manner, a new and splendid edition of the conchological writings of Say. See ante, page 163.

Mr. Binney is at present engaged in an extensive work for the Smithsonian Institution. He is preparing for them descriptions of our Terrestrial and Fluviatile Gasteropoda, for cheap publication and free distribution. He has also just completed a work on the Synonymy of American Shells, forming a very large paper—the MSS. extending to several hundred pages.

The publication of these works will mark a new era in the progress of Conchology among us, as it is believed that their distribution will very much enlarge the number of students of the science; the scarcity and high cost of works of reference having hitherto proved a discouraging barrier to persons of limited means. Now, however, the Smithsonian Institution intends providing the proper works of reference, free of cost.

Mr. Binney is very methodical in his writings—which, without any pretension, reveal the utmost deliberation and profound study on the part of the author. He possesses a nice discrimination of specific values, and is exceedingly well informed in the general history and bibliography of the science.

PHILIP P. CARPENTER, of Warrington, England, well known by his comprehensive Report to the British Association, on our West Coast Mollusca, prepared a list of those shells for the Smithsonian Institution. It has also published, recently, a volume of "Lectures on Mollusca," by this gentleman.

A. D. BROWN, of Princeton, N. J., has just published in the Proceedings of the Academy of Nat. Sciences, descriptions of new species of Helix. Mr. Brown is a close student of the Terrestrial Mollusca, and will doubtless become one of our leading conchologists.

We have thus noticed the principal writers on shells, in America, to the present time. We must regret that want of space has

compelled the omission of much that would be of interest to the reader, who is referred, for a more complete list of Authors and their Papers, together with accurate dates of publication, to the work at the head of this article, which has furnished us with most of the material for the foregoing pages.

It will be seen that our several scientific Journals have contained a very large number of papers by our best authors—thus, the publications of the Boston Society have those of Adams, A. Binney, Couthuoy, Gould, Prime, &c. The New York Annals those of Adams, Anthony, Bland, Newcomb, Prime and Redfield. The Journal and Proceedings of the Philadelphia Academy have the valuable papers of Say, Conrad, Anthony, Lea, W. G. Binney, Leidy, Prime, Stimpson, &c. The Philosophical Transactions contain many of Lea's extensive articles; while papers by many of these authors have also appeared in this Journal.

There are many fine public and private collections of shells in the United States. That of the Academy of Natural Sciences embraces about eleven thousand species. In the arrangement of the Academy's Cabinet, Pfeiffer's system is followed for the terrestrial species, while with the fluviatile and marine shells, the Lamarckian system is generally adhered to, with the introduction, however, of many of the more recent genera.

The splendid collection belonging to Amherst College is a noble monument of the unflagging assiduity and scientific attainments of the late Prof. C. B. Adams, who formed it. It embraces types of all his species and full suites of the shells of the various West India islands, and of Panama. It is esteemed by competent judges the most valuable collection for study in the United States.

The Boston Society of Natural History, the New York Lyceum, the Mercantile Library Co. of Cincinnati, Union College, Schenectady, N. Y. (formerly collection of C. M. Wheatley, of Phœnixville, Pa.), the Agassiz Museum and the Smithsonian Institution, each possess valuable collections.

The largest private collection in this country is that of Dr. John Clarkson Jay, of Mamaroneck, N. Y., numbering 13,460 species and numerous varieties. They are arranged according to the Lamarckian system. We have already alluded (p. 169) to his extensive and useful catalogues of his collection.

Wm. S. Haines of New York possesses twelve thousand species of shells, including many rare and unique ones.

Mr. Binney has a small but exceedingly valuable collection of the terrestrial shells of the United States, including many types of species, and also geographical series. The same may be said of the cabinet of Mr. Bland of New York.

Mr. Lea's cabinet of Unionidæ is unequalled in the world. It includes many thousands of carefully selected specimens from all parts of the world, exhibiting all the variations from specific types so common in this family.

Dr. Gould possesses a valuable collection, containing many types of species.

The most valuable cabinet of West India terrestrial shells is that of Mr. A. D. Brown, of Princeton, N. J., formerly the property of Thomas Bland. Mr. Bland's extensive correspondence in the West Indies, and especially with Prof. Poey, Dr. Gundlach, M. Sallé, R. J. Shuttleworth, &c., his own collections in St. Thomas, Jamaica and Bermuda, and his intimate relations with the late Prof. C. B. Adams, gave him extraordinary advantages and opportunities. Mr. Brown also has a large number of species of terrestrial mollusca from other countries—the whole amounting to three thousand species.

John G. Anthony of Cincinnati has a fine collection of American freshwater shells, principally Melanians, collected by himself.

The finest cabinet of operculated land shells is that of Mr. J. H. Redfield, late of New York, now of Philadelphia; he has also a large collection of Marginellidæ, which he has made his especial study.

The collections of Temple Prime and Wm. Stimpson are exceedingly rich in their respective specialities, the Cyclades, and American marine mollusca.

Dr. E. Ravenel, of Charleston, S. C., an experienced conchologist, and one who has done much to further the study among us, possesses a valuable cabinet, rich in marine and other species, determined by Thomas Say.

There are numerous private collections in this country containing from one to five thousand species; among these may be mentioned those of Hon. E. Cowan of Pennsylvania, U. S. Senator; Theodore Gill, containing three thousand species; Dr. E. R. Foreman of Washington, D. C., thirty-five hundred species; and R. L. Stewart of New York.

The c binet of Geo. W. Tryon, Jr., of Philadelphia, embraces over four thousand species, and many varieties. It includes a large number of American Unionidæ and Melaniadæ, supplied by Isaac Lea, Mr. Binney, and numerous others: a good suite of American terrestrial shells from Mr. Binney, many West Indian land shells, including a number of Adams' Jamaica species, and of Pfeiffer's (author's examples), and a fine Cuban suite from Prof. Poey; a splendid collection of Achatinellæ from Dr. Newcomb, a series of European terrestrial shells (several hundred species) from Terver of Lyons, besides numerous American and foreign marine shells, including a suite of Carpenter's Mazatlan shells.

Mr. D. Jackson Steward of New York, has also an extensive cabinet. It embraces that of the late Mr. Lounsbury, and the interesting collections, especially of marine species, made for Mr. Steward in Trinidad, Barbadoes, &c., by Mr. Theodore Gill.

It would much transcend the limits of this article to enumerate the numerous excellent conchologists and collectors, who though writing but little or nothing themselves, have yet, by furnishing *materiel* to our authors, and by the distribution of specimens, much aided the progress of the science. Among these are men of high attainments, such as the late Dr. R. E. Griffiths, P. H. Nicklin, and John S. Phillips of Philadelphia, Dr. Lewis of Mohawk, N. Y., Mr. Theodore Gill, Dr. E. R. Showalter, Uniontown, Ala., Bishop Elliot, of Georgia, Edmund Ravenel and Lewis R. Gibbes of Charleston, S. C., Thomas Nuttall, &c. The works of Messrs. Lea, Binney, Conrad, Stimpson, and others, contain many acknowledgments of specimens sent and information rendered by these and numerous other persons in all parts of the Union.

The present condition and prospects of conchological science in America are very encouraging, and its pursuit offers a fine field for the investigation of our young naturalists. The largest part of this continent is still unexplored for Mollusca, and rich discoveries will continue for years to reward the labor of investigators.

It may be asked—what benefit to mankind has resulted from the pursuit of this science? We might perhaps answer, that its great merit consists in affording an innocent recreation to the mind of man. But there is surely a nobler object to be gained by the study of conchology. God, who created man in His own image, has also placed around us a host of living things, each after its own kind, an exemplification of divine wisdom, in the admirable adaptation of means to ends, as shown in their organism and mode of life; and who shall say that it is profitless for man to examine these animals, endeavor to indicate among them groups approaching each other in various degrees of relationship, and to learn, as far as we may know it, the plan of the Creator in their formation. As God has not considered these animals unworthy His attention, surely they are worthy of our earnest study.

Besides this ethical view of our science we must not forget to what a wonderful degree Conchology has become the handmaid of Geology. Through every geological horizon, from the earliest dawn of life to the deposits now forming, the palæontologist is of necessity a conchologist. If certain organic forms merit the distinction of 'Medals of Creation'—Mollusca, from their abundance in all geological ages, may be called its current coin.

ART. XVIII.—*Physics and Hydraulics of the Mississippi River.**

THE volume with the subjoined title constitutes No. 4, of Professional Papers of the Corps of Topographical Engineers, United States Army, and is published by authority of the War Department, Bureau of Topographical Engineers. It requires but a cursory examination to authorize the conclusion that this work is the most important one ever issued by this Bureau, and one of the most profoundly scientific publications ever published by the U. S. Government. The authors, commencing with a quotation from one of Franklin's letters to the Abbé Souliave as their motto,—"I approve much more your method of philosophizing which proceeds upon actual observation, makes a collection of facts, and concludes no further than those facts will warrant,"—seem to have adhered to it literally, collecting a mass of facts and statistics which must ever remain a monument to their unwearied industry and patient accuracy. But we cannot present a better idea of the object and scope of the work before us than by citing the following extracts from the able introductory letter of Capt. Humphreys:

"Some reference to the state of the question of protection against inundation, at the time when the survey of the Mississippi Delta was begun, appears to be proper here, in order that the necessity of such extended and laborious investigations as were made may be appreciated, and that it may be understood how absolutely essential it was in every division of the subject to collect fact upon fact, until the assemblage of all revealed what were and what would be the true conditions of the river in every stage that it had passed through or could attain, and thus to substitute observed facts, and the laws connecting them, for assumed or imperfectly observed data and theoretical speculations.

A wide discretion was necessarily entrusted to the officer in charge of the Mississippi Delta Survey. I entered upon the execution of that duty with an apprehension that the laws of flowing water in natural channels, as enunciated in treatises upon the hydraulics of rivers, were not based upon sufficiently extended experiments upon natural streams, and hence that the

* Report upon the Physics and Hydraulics of the Mississippi River; upon the Protection of the Alluvial Region against overflow; and upon the Deepening of the Mouths; based upon surveys and investigations made under the acts of Congress directing the Topographical and Hydrographical survey of the Delta of the Mississippi River, with such investigations as might lead to determine the most practicable plan for securing it from inundation, and the best mode of deepening the channels at the mouths of the river. Submitted to the Bureau of Topographical Engineers, War Department, 1861. Prepared by Capt. A. A. HUMPHREYS and Lieut. H. L. ABBOT, Corps of Topographical Engineers, United States Army. 4to, pages 456, with an appendix of 146 pages and a large number of maps and charts. Philadelphia, J. B. Lippincott & Co.

formulæ found in them, could not be relied upon for the solution of the questions upon which the plans of protection against inundation from overflow depended. The system of measurements and investigations carried on at Carrolton, Louisiana; Vicksburg, Mississippi; and Columbus, Kentucky; while it was intended to render the solution of the problem of the protection of the alluvial region of the Mississippi against inundation independent of the laws and formulæ of the books, was at the same time designed, in connection with other parts of the Survey, to afford the means of determining, by experiments on a far more extended scale than any ever before attempted, the laws governing the flow of water in natural channels, and of expressing them in formulæ that could be safely and readily used in practical applications. The success that has attended this part of the work has even exceeded my expectations. Laws have been revealed that were before unknown; new formulæ have been prepared, possessing far greater precision than the old; and improved methods of gauging streams have been devised.

But the imperfect state of the science of hydraulics as applied to rivers was not the only difficulty to be encountered in the execution of the duty imposed upon the officer in charge of this work. The much agitated question of the best method of protection against inundation had been always discussed upon assumed data, and the truth of the very groundwork upon which these discussions rested had to be experimentally investigated by this Survey. For instance, the Mississippi had always been regarded as flowing through a channel excavated in the alluvial soil formed by the deposition of its own sedimentary matter. So important an assumption was inadmissible; and great pains were accordingly taken to collect specimens of the bed wherever soundings were made, and by every means to ascertain the depth of the alluvial soil from Cape Giradeau to the Gulf. This investigation has resulted in proving that the bed of the Mississippi is not formed in alluvial soil, but in a stiff, tenacious clay of an older geological formation than the alluvion, and that the sides of the channel do not consist of homogeneous material; facts that have an important bearing upon all plans of protection.

Further, it was held by the advocates of the exclusive use of artificial embankments that the levees of Louisiana had already lowered the bed and floods of the Mississippi river, and that their extension throughout the alluvial region above would still further lower the floods by deepening the bed and reducing the slope of the river. The advocates of outlets, on the contrary, contended that the experience of many centuries, on the Po, proved that levees had raised the bed and floods of that river—to such an extent, indeed, that it was impracticable any longer to protect the country, except by opening new channels to the

sea. This conclusion appeared to be sustained on the authority of two distinguished names, Cuvier and de Prony. While the investigations of the Delta Survey have rendered untenable that position of the advocates of the exclusive use of levees on the one hand, the investigations of the Chevalier Elia Lombardini have shown the supposed facts advanced by the latter class to be entirely erroneous, and their apprehensions to be unfounded.

The effects of cut-offs were likewise the subjects of controversy among engineers, a controversy which the measurements of the Delta Survey must set at rest, since they demonstrate that cut-offs raise the floods below them, a conclusion sustained by the well-established effects of such works upon the Po and Adige.

Outlets were advocated by some engineers because they were considered a ready and inexpensive means of reducing the floods. On the contrary, they were objected to by others because, as they claimed, outlets would raise the bed and floods of the river. The investigations of the Delta Survey prove that outlets, in the few localities where they are practicable, may be made to reduce the floods to any desired extent in certain divisions of the river; but that they would not be inexpensive, and would entail dangers and disasters which should not be risked. These conclusions, it is shown, are sanctioned by the experience of Europe, upon the Po, the Rhine, and the Vistula.

The effect of a great swamp like that of the Yazoo upon the floods of the Mississippi, a subject that has formed the theme of speculation for at least thirty years, has also been established by the collection of facts; as likewise the law governing the rise, fall, and discharge of the river throughout the alluvial region; the manner in which the flood is propagated; the modifications introduced by tributaries; the succession of river stages; the drainage of its basin and that of its tributaries; the proportion of drainage to downfall; and the discharge of outlets: in fact, every river phenomenon has been experimentally investigated and elucidated.

Thus every important fact connected with the various physical conditions of the river and the laws uniting them being ascertained, the great problem of protection against inundation was solved.

At the mouths of the river, a similar course has resulted in the development of the law under which the bars are governed, the depth upon them maintained, and the regular advance into the gulf continued; and, as a consequence, the principles upon which plans for deepening the channels over them should be based, and the best mode of applying them. The rate at which the river progresses into the gulf, and the extent, thickness, and relative level of the alluvial formation having been ascertained, its probable age has been estimated; and the ancient form of

the coast, and the changes that have taken place in the present geological age, have been surmised.

The Report exhibits in detail the investigation of each of these subjects, and many others not enumerated in this letter. Based upon extended survey and investigation in the field, made at times under circumstances of great exposure, it contains the results of many years labor, comprising laborious office work, extended research, patient investigation, and exhaustive mental effort."

The first chapter treats of the great basin of the Mississippi River as well as the basins of its numerous tributaries, their slope, dimensions of cross-section, range, navigation, succession of stages, topography, geology and growth of the bottom lands, floods, &c.

"The Mississippi drains the greater part of the territory of the United States lying between the Alleghany and the Rocky Mountains. Its basin, more than equal in area to the whole continent of Europe, exclusive of Russia, Norway, and Sweden, is greatly diversified in features, in soil, in climate, and in productions. A knowledge of the hydrographic relations of the different parts of this basin to the main river is essential to a full appreciation of all the elements of the problem, the solution of which forms the subject of this report. The region is too vast and diversified to be treated under a single head, and some convenient and natural subdivision is therefore to be sought.

The true Mississippi river begins at the confluence of the Missouri and Upper Mississippi. It has eight principal tributaries, which, in the order of the magnitude of their basins, are the Missouri, the Ohio, the Upper Mississippi, the Arkansas, the Red, the White, the Yazoo, and the St. Francis. It may excite some surprise that the two latter are included in this category, but it will be hereafter seen that, although comparatively small streams, they are important from their position and volume of discharge. Just below the confluence of Red River is found the first of the bayous which, fed by the Mississippi, discharge into the gulf. Below this point the Mississippi receives no appreciable increase from tributaries; it may, therefore, for these two reasons be considered the head of the delta.

The delta and the basins of the eight tributaries form natural subdivisions of the great basin. They include the whole area except the small basins of several comparatively unimportant branches which may be classed together under one general heading. As it is proposed to state, in this chapter, such facts in relation to these several subdivisions as shall exhibit their hydrographic relations to the main river, it is, in some sort, an introduction to the report.

Missouri Basin.—This is much the largest of any of the tributary basins of the Mississippi, and differs from all the rest in containing a large area covered by lofty mountain chains. The river issues from the Rocky mountains in many branches, which form a series of large rivers that flow through the great uncultivated plains. Comparatively little rain falls upon the mountains and the plains, and hence the size of the main river is disproportionately small, when the drainage area alone is considered. Its annual discharge is only about three-quarters of that of the Ohio, although its basin is nearly two and a half times as large. After passing the 98th meridian, the banks of the river become more and more fertile, and the region through which it passes gradually changes from an uncultivated waste to a populous country. The total area of the basin, including the mountains, the plains, and the fertile region, is 518,000 square miles.

Missouri River.—Ascending the river, the Missouri is found to divide at Fort Union into two main branches of about equal size, the Yellowstone and the Upper Missouri. About 265 miles above its mouth, the former again divides into two nearly equal branches, the Big Horn and the Upper Yellowstone. The Upper Missouri remains a single stream to within about 100 miles of its sources, where it divides into three forks, named Jefferson, Madison, and Gallatin. It was first explored to the sources of Jefferson fork by Captains Lewis and Clarke, U. S. A., in 1806. When returning, Captain Clarke followed up Gallatin's fork a short distance, crossed over to the Yellow Stone near where it issues from Snow mountains, and passed down the river in canoes to its mouth. The next expedition was conducted in 1833 by Captain Bonneville, who then explored a portion of the Big Horn river. The maps of this region made by these early explorers have been superseded by more accurate surveys, conducted chiefly upon the Upper Missouri branch by detachments of Governor Stevens' Pacific Railroad party, in 1853; but so far as a knowledge of the sources of the Missouri river are concerned, very little additional information had been acquired previous to the year 1859. At this date, a party under Capt. W. F. Raynolds, U. S. Topl. Engrs., was organized by the War Department, to explore the region. This party accurately mapped the Yellowstone from its mouth to the point where it issues from the Snow mountains; the Big Horn to its sources; the Madison fork to its sources; and acquired definite information respecting the Gallatin fork and the Upper Yellowstone. The report has not yet been published, but through the kindness of Captain Raynolds, with the sanction of the War Department, the following facts have been communicated:

In lat. 43° 30′ and long. 110° 00′ a mountain rises to some

14,000 feet above the level of the sea. It is named by Capt. Raynolds, Union Peak, because water trickling from its northern side flows into the Mississippi, from its southern side into the Great Colorado, and from its western side into the Columbia. Within one degree of longitude westward and about one degree of latitude northward from this peak are four of the sources of the Missouri, where the Big Horn, the Yellowstone, and the Madison and Gallatin forks take their rise.

The Big Horn (here called Wind river) flows south-eastwardly to long. 108° 30′, through a narrow bottom land, varying from one to three miles in width, bounded on the south side by the impassable Wind-river chain, and on the north by an elevated prairie rising into mountains. It is then joined by the Popo Agie and turning abruptly toward the north, forces its way through the Big Horn mountains, here forming a double chain, to the prairies bordering upon the Yellowstone.

The Madison fork flows northward, chiefly through a rugged defile, to the junction of the three forks, where it is joined first by the Jefferson fork. This is rather the larger river of the two, and heads among beautiful Rocky mountain valleys, about two degrees of longitude farther to the westward. Neither of these streams is fordable near its mouth. About half a mile below their junction, the Gallatin fork, smaller than either of the others, enters from the southeast. These three forks unite in an extensive plain surrounded by lofty mountains. The united waters soon enter, and for nearly a degree of latitude traverse a succession of mountain valleys and enormous cañons.

Between the Big Horn and Upper Missouri branches, in long. 110° 30′ and lat. 44° 30′, the Upper Yellowstone has its source in a lake, as yet only visited by trappers and Indians, whence it plunges through an impassable gorge to the highest point visited by Capt. Raynolds' party. From this point, where it is two hundred yards wide and six feet deep, it winds to the northeast, through a narrow valley, to the mouth of Clarke's fork. In this distance it is characterized by many islands, and by bold, sweeping curves, frequently impinging upon the hills. Between Clarke's fork and the mouth of the Big Horn, the river is from 500 to 600 yards in width, unobstructed by rapids, and flowing with a swift current of some three or four miles per hour.

Below Big Horn river, to Powder river, the width increases to 800 or 900 yards, and the river becomes turbid, resembling the Missouri.

From Powder river to the Missouri the banks are low and caving, and the river assumes the characteristic appearance of the Missouri, containing numerous sand bars, densely timbered islands, &c. There are also some rapids and shoals.

Capt. Raynolds is of the opinion that the Yellowstone can be

navigated with boats drawing three feet of water, up to the point where it issues from the mountains, from the middle of May to the first of August. The floods are neither sudden nor excessive, and the river is probably better adapted to steamboat navigation than the Missouri, although there are difficult rapids at the mouth of Powder river."

The second chapter, which is also one of great interest to the geologist, is confined more especially to the valley of the Mississippi below the junction of the Missouri. It treats of its geology—the artesian well at New Orleans—growth of the river banks—changes of the bed—oscillations of the Gulf, and their effects upon the lakes and river—tidal oscillations of the river—hurricanes and their effects—range of the Mississippi between high and low water—elevation above the gulf—of the surface of the river—usual succession of stages—dimensions of cross-section—yearly amount of rain in the basin—annual discharge of the Mississippi and its principal tributaries—ratio between rain and drainage in the basin—sedimentary matter in the Mississippi water—matter rolling along upon the bottom—temperature of the water—history of the progress of levees in the Mississippi valley—levee organization in the different states—dimensions and cost of existing levees—the earlier floods and those of 1828, 1844, 1849, 1850, 1851, 1858, and 1859. But we have room for the following extract only, from page 178:

"The last and greatest rise in the flood of 1858 occurred at the head of the alluvial region, in the month of June. About the middle of May, extensive rains prevailed in the Ohio valley, and occasioned much damage by flooding the small streams. They also prevailed west of the Ohio basin and caused a rapid rise in the lower tributaries of the Upper Mississippi and Missouri. These rains continued, especially in the states of Ohio, Indiana, Illinois, and Missouri, raised the Miami, Wabash, and Illinois rivers to unprecedented heights, and filled all the lower tributaries of the Missouri. The usual June rise of the latter river, occasioned by the melting of snow in the Rocky mountains, and the spring and early summer rains along its course, arrived just in time to contribute its waters to the general flood. With the Ohio and Mississippi both in full flood, the torrent which poured into the alluvial region by the river itself and through the swamps above Columbus, was immensely greater than in any of the earlier rises of the year, and second to none of which we have records. For seven days (June 16–22) it amounted to 1,475,000 cubic feet per second. It inundated the city of Cairo. It washed away miles of the insignificant levees along the St. Francis front, and poured rapidly into the bottom lands of that river, which were already deeply overflowed from heavy rains and from the crevasses of the April rise. So small

was the actual reservoir capacity of that region that the channels of the six large bayous, and of the St. Francis itself, were insufficient to give water-way to the flood, returning to the Mississippi. For miles above Stirling, it poured over the banks themselves, washing the remains of the levees into the river. It passed like a great wave through the swamp, causing the deepest overflow ever known. Collecting again, in this manner, at Helena, in about two weeks after it entered the alluvial region, it poured with renewed force upon the lower country. In the White-river swamps, the same conditions existed as in the St. Francis bottom. The Yazoo and Tensas bottoms, on the contrary, were comparatively empty, owing to the general resistance of their levees in the former rises, and served in some degree as reservoirs to diminish the height of the flood below. The former was deeply inundated, although the Yazoo river was returning more than 125,000 cubic feet per second during the whole rise. The latter escaped almost entirely, its bayous being sufficient to carry off the limited amount of crevasse water, and discharge it into Black river, whence it passed down bayou Atchafalaya. Below Red river landing, the levees remained unbroken except at the Belle and LaBranch crevasses which submerged the country between the Mississippi and bayou LaFourche. Fortunately, the upland tributaries below the Ohio were all low during this great rise, for to this circumstance alone is due the escape of the lower country from general overflow.

The June rise terminated the flood. At the head of the alluvial region, the river fell rapidly to low-water mark, being only retarded by a slight rise which occurred in July. The water that drained from the great St. Francis and Yazoo bottoms maintained the flood discharge at points below them for about six weeks; after which the lower river also subsided rapidly to its lowest stage for the year."

The third chapter presents the state of the science of Hydraulics as applied to rivers. The topics are the early history of hydraulics—epoch of Gugliemini—era of modern experimental investigation—new system of notation—various methods of measuring the velocity of rivers—velocity below the surface in any given vertical plane—horizontal curves of velocity—true mean velocity, and the methods of various authors for obtaining the true mean velocity of rivers.

"The solution of that great problem, the best method of preventing the overflows of the Mississippi, exacted difficult measurements and extremely intricate computations. In connection with it, a careful examination of all writings upon hydraulics that were within reach was made, to ascertain precisely the present state of that science; a list of the principal publications upon the subject, with a brief synopsis of those parts of their

contents that are connected with the present problem, has been prepared for future reference. It will be found from this that the laws which govern the flow of water in natural channels were only partially and imperfectly developed; but, as a knowledge of those laws was essential to the determination of the plans of protecting the Mississippi valley from inundation, the investigations of the Delta Survey, conducted with that object, in accomplishing it, have necessarily contributed to the advancement of hydraulics. An account of these investigations will be presented in full detail in the two following chapters. This chapter is devoted to a brief notice of published works, which is partly original and partly compiled from similar notices by Rennie, Lombardini, Storrow, and others, and from various encyclopædias."

The following are some of the subjects discussed in the fourth chapter on the method of guaging the Mississippi, its tributaries and its crevasses:—Method of determining dimensions of cross-section—method of conducting velocity measurements—computation of discharge, neglecting change of velocity below the surface—investigation of sub-surface curve of velocity—same of the horizontal curve—parameter law deduced—equation for mean of whole vertical curve—locus of maximum velocity below the surface—system of interpolating discharges—method of transferring measured discharges, &c.

Chapter fifth treats of the experimental theory of water in motion—application of the new laws to the guaging of rivers by measurement—application of the new laws to the guaging of rivers by formulæ, &c.; chapter sixth, protection against the floods of the Mississippi; chapter seven, Delta of the Mississippi; chapter eight, mouths of the Mississippi—bars at the mouth and plans for increasing the depths of the bars, &c.

The preceding extracts convey but an inadequate idea of the extent and importance of this work. Many portions of it cannot be properly appreciated except by those who possess a profound knowledge of mathematics and general physics. We shall take care to transfer to our pages under the proper heads the new physical constants and formulæ which the Report contains. There is much however in regard to the floods, velocity of currents, amount of sediment conveyed by the river, and the superficial deposits of the Valley of the Mississippi and its tributaries, which cannot fail to aid greatly the researches of the geologist as well as the physicist. The volume itself is a model of systematic arrangement, clearness and beauty of typography, and is singularly free from typographical errors. It would add much to the credit of the general government if this volume could be used as a model for the style of its future scientific and military publications.

ART. XIX.—*Contributions to Mineralogy;* by F. A. GENTH.

1. *Gold, pseudomorph after Aikinite.*

IN a former communication (this Journ., [2], vol. xxviii, 246–255) I have called attention to the occurrence of gold in pseudomorphs and other forms and associations, which admit of no doubt that it must have been in solution, previous to its deposition in veins or beds. I have lately received a new and very interesting fact confirming this opinion in a specimen which shows gold pseudomorphous after aikinite. The exact locality from which my specimen comes is doubtful, but it is stated to be from Georgia. It is a small piece about $1\frac{1}{2}$ inches square and about $\frac{3}{4}$ of an inch thick, and consists of greyish white crystalline quartz with minute druses of crystallized quartz, one side of it covered with an earthy manganiferous hydrated ferric oxyd. The quartz has the appearance of that from many of the gold veins of our Southern States. In one place it shows particles of unaltered aikinite, the greater portion of this mineral however is converted into the well known pseudomorph (as proved by the blowpipe), a cupreous carbonate of bismuth in slender needles of different degrees of purity, of a waxy lustre and a pistachio or oil-green, when earthy, of a greenish white color. The centre of these crystals is in many of them taken up by bright yellow gold of a high degree of fineness, some of them distinctly showing the rhombic form of the original mineral.

It is easy to conceive how this pseudomorph has been formed, when we take into consideration that in the oxydation of the aikinite sulphur, lead and copper were oxydized first, and the bismuth may have been eliminated, occupying the centres of the crystals; but afterwards, when coming in contact with a solution of gold, precipitated it, the bismuth being carried off by the electro-negative element, previously in combination with the gold.

Specimens from Beresofsk, containing both aikinite and gold in quartz, which I have examined, did not show anything similar; where both minerals are found intermixed, the gold occurs in irregularly shaped particles, evidently formed *simultaneously* with the aikinite and *not after* its decomposition.

2. *Antimonial Arsenic and Arsenolite.*

An interesting variety of *antimonial arsenic* in reniform finely crystalline, somewhat radiated masses of a color between tin-white and iron-black on a fresh fracture, but greyish black from tarnishing, occurs at the Comstock 'lead' of the Ophir Mine, Washoe county, California. Being associated with arsenolite, calcite and quartz, the material for examination was first treated

with a mixture of dilute chlorhydric and tartaric acids. The solution thus obtained, contained *no* antimony, but lime, magnesia, ferrous oxyd and arsenious acid, corresponding with:

Carbonate of lime,	86·78 p. c.	89·43
" " magnesia,	2·05	
" " iron,	0·60	
Arsenious acid,	10·80	10·80
	100·23	

The residue dissolved in a mixture of chlorhydric acid and chlorate of potassa, left behind some quartz, which was filtered off and the arsenic separated from the antimony by Levol's method; the following results were obtained:

Quartz,	11·02 p. c.
Arsenic,	80·81
Antimony,	8·17

Of the isomorphous metals $\frac{1}{11}$ is antimony. After deducting the quartz the composition is:

	Found.		Calculated.
Arsenic,	90·82	$\frac{11}{12}$ Arsenic,	90·81
Antimony,	9·18	$\frac{1}{12}$ Antimony,	9·19

It resembles in its composition the antimonial arsenic from the Palmbaum Mine near Marienberg, Saxony, analyzed by Schultz, containing 92·03 per cent of arsenic and 7·97 per cent of antimony. (Rammelsberg's Mineralchemie, p. 984.)

3. *Arsenids of Copper.*

*a. Whitneyite.**—After the publication of the results of my examination of the peculiar arsenid of copper from Lake Superior, introducing *whitneyite* as a new species (this Journal, [2], xxvii, 400), I learned of the existence of several specimens of arsenids of copper from Lake Superior, and that some qualitative examinations had been made of one of them by Dr. John Torrey even as early as 1853, which, however, have never been published. I have been very anxious to get some of this material for examination. Prof. Jas. C. Booth, who was fortunate enough to secure one of these early specimens, has with the greatest liberality presented me with a sufficient quantity from it for investigation. The locality is stated to be on the north shore of Lake Superior.

It had a brownish tarnish and in some places showed rainbow and pavonine colors. On examination it proved to consist of two minerals, *whitneyite* and *algodonite*, and although it was almost impossible to get them separated in a state of absolute purity, the analyses will show that this has been done sufficiently to prove the correctness of the determinations of the species.

* It is surprising that even after Prof. George J. Brush (9th suppl. to Dana's Mineralogy, this Journal [2], xxxi, 370,) has noticed the oversight of D. Forbes (Phil. Mag. [4] xx, 423) giving the new name "Darwinite," to a species established nearly two years previously, this name is still continued by F. Field.—(Philos. Mag., [4], xx, 423).

This whitneyite is compact, with an exceedingly fine-grained structure, (far more so than that from the Pewabic location, which is rather coarse grained,) and a reddish, greyish white color and no lustre on surfaces of fresh fracture. Scratching developes strong metallic lustre and a reddish white color, but it soon tarnishes. Probably owing to some porosity the sp. gr. was found to vary from 8·246 to 8·471 (at 21° C.), the hardness is a little below that of fluor. It is slightly malleable. Fracture subconchoidal. The analysis of the purest pieces gave:

	I.	II.	III.	Theory.
Arsenic,	10·92*	12·284	12·277	11·64
Copper,	87·64	87·477	87·371	88·36
Silver,	0·19	0·040	0·032	
	98·75	99·801	99·680	

b. Algodonite.—α. The dense whitneyite changes gradually into a mineral of larger crystalline grains, a more greyish white color and metallic lustre. When polished it is almost silver-white. The purest of it forms the lining of little cavities as minute crystals, too indistinct, however, to determine their form; they have the composition of algodonite; a slight admixture of whitneyite generally gives the arsenic a little too low. I found:

	I.	II.	III.	Theory.
Arsenic, - -	15·30	15·56†	16·72	16·50
Copper, - -	84·22	84·10	82·35	83·50
Silver, - -	0·32	0·34	0.30	——
	99·84	100·00	99·37	

β. For comparison with the arsenids of copper from Lake Superior, Prof. G. J. Brush kindly communicated a few fragments from a Chilean specimen, received last April by Prof. Dana from Prof. Domeyko—labelled: "Arseniure de cuivre pur, du Cerro de las Seguas, Depart. de Rancagua."

The purest pieces consisted of a very fine grained steel grey dull mineral, when magnified it showed silver-white somewhat larger specks disseminated through the mass. Admits of a fine polish, when polished it has the color of an alloy of copper and silver, containing about 60 p. c. of the latter metal. Tarnishes easily, scratches fluor with difficulty. The sp. gr. of an apparently pure piece at 25° C. was =7·603; fracture subconchoidal; brittle. Associated with cuprite, malachite, barytes, etc. The analyses gave:

	I.	II.	III.
Arsenic, - - -	17·46	16·94	16·44
Copper, - - -	81·82	82·33	83·11
Silver, - - -	*trace*	*trace*	*trace*
	99·28	99·27	99·55

* An accident in drying the precipitate of $2MgO, NH_4O, AsO_5+HO$ compelled me to determine the arsenic as $2MgO, AsO_5$, which gives it always too low.

† From the loss.

c. Domeykite.—*α.* The first observation of the occurrence of domeykite on Lake Superior was made by T. Sterry Hunt (this Jour. [2], xix, 417), who detected this mineral by its tin-white color, and the results of his analyses in the peculiar mixture of copper-nickel and domeykite from the Michipicoton Island. J. D. Whitney (this Jour. [2], xxviii, 15), remarks that it appeared homogeneous in composition, of the general appearance of copper-nickel, forming nodules with a structure in concentric layers. I have in my collection two little pieces of it, the first received about two years ago from Prof. Whitney, and another a short time ago from Prof. Brush. The latter, when received, had a fresh fracture and showed distinctly the mechanical mixture of the copper-nickel with a tin-white mineral, which however, quickly tarnished. The other was quite homogeneous, when obtained, but of a paler color than copper-nickel. Now, after having been exposed to the atmosphere for two years it can be distinctly seen to be a mechanical mixture, the domeykite having tarnished and become brown, while the copper-nickel still retains its bright color and metallic lustre. The concentric structure has become quite visible; the nearly pure (now brown) domeykite occupying the centre, covered by a layer of nearly pure copper-nickel, followed again by domeykite, which is surrounded by copper-nickel. The layers are about $\frac{1}{16}$th to $\frac{1}{12}$th of a line in thickness.

β. In the Portage Lake Mining Gazette, vol. ii, No. 9, of September, 1860, an article appeared headed "*A new mineral,*" in which it was stated that a large mass of vein rock with a great amount of arsenical copper had been discovered on the surface of the Sheldon location near the course of the Isle Royale vein, the matrix consisting principally of quartz with some prehnite and a little epidote. It is described as fine steel-grey, very brittle like copper pyrites, of about the same hardness, and consisting of copper and arsenic, without any sulphur. From this description I suspected the *new mineral* to be domeykite, and at my request John F. Blandy, Esq., very kindly furnished me with a portion of the material for examination. I am also indebted to Prof. Brush for a very fine piece, which he lately brought from the same locality.

Massive. Hardness a little below that of fluor; sp. gr. at 16° C. = 7·750; color on a fresh fracture between tin-white and steel-grey, quickly tarnishing, first changing into yellowish and pinchbeck, afterwards into beautiful pavonine and rainbow colors, at last turning brown. Lustre metallic when fresh, dull after oxydation. Fracture uneven, somewhat subconchoidal.

One of my specimens shows a thin coating of an arseniate of copper, probably olivenite.

Quartz being so much intermixed with the mineral, it is difficult to obtain material for analysis quite free from it. The quantity in analysis I, was 0·55 p. c., in II, 6·71 p. c., which were subtracted, leaving for the pure mineral:

	I.	II.	Theory.
Arsenic, - - -	29·25	29·48	28·32
Copper, - - -	70·68	70·01	71·68
	99·93	99·59	

It is certainly a very remarkable fact that the Lake Superior copper region as well as Chile furnish the *three* arsenids of copper, neither of which has, as far as I know, been observed at any other locality, excepting the impure variety of domeykite (condurrite), which occurs at one or two mines in Cornwall.

4. *Copperglance pseudomorphous after galena* (Harrisite, Shepard.)

When I pronounced *harrisite* to be a pseudomorph of copperglance after galena, (this Journ., [2], xxiii, 415,) I little thought that soon after, by the discovery of Dr. John Torrey (who communicated to me specimens from the Canton mine, Georgia, still containing a nucleus of unaltered galena, noticed by Prof. Brush in the 9th supplement to Dana's Mineralogy), my suggestion would be proved to be a positive fact.

I received about one year ago from a *new* locality several specimens of this interesting pseudomorph from the discoverer, Alexander Trippel, Esq., Superintendent of the copper works in Polk county, Tennessee. They occur at the East Tennessee mine, Polk county, in a feldspathic rock, associated with chalcopyrite, pyrites, blende, garnet and lime-epidote (see No. 9 below); their color varies between dark lead grey and blueish black; frequently they contain a nucleus of almost unaltered galena, while others are almost pure copper-glance, or intermediate states of alteration. A portion of the copper present is in the form of covelline, as already indicated by the blueish color of several pieces and confirmed by the analyses. The following results were obtained:

	I. Nucleus of galena.	II.	III.	IV.	V.	VI.
Lead,	84·33	12·55	11·38	2·85	1·07	0·41
Silver,	0·72	0·50	0·73	1·10	0·20	0·16
Copper,	0·94	66·27*	67·45	74·90*	76·40	70·44
Iron,	0·20	0·51	0·40	0·40	0·65	4·11
Sulphur,	14·27	20·17	20·04	20·75	20·60	24·07
Selenium,	*trace*	*trace*	*trace*	*trace*	*trace*	*trace*
Quartz,	....	....	....	....	0·11	....
	100·46	100·00	100·00	100·00	99·03	99·19

The rational composition of the above analyses would be:

* From the loss.

Galena,	97·41	14·50	13·14	3·29	1·24	0·47
Silverglance,	0·83	0·57	0·84	1·26	0·23	0·18
Covelline,	1·41	5·02	4·11	4·70	2·26	9·03
Copperglance,	....	78·82	81·05	89·89	93·80	80·70
Pyrites,	0·43	1·09	0·86	0·86	1·39	8·81

It may be interesting to give for comparison the results of an analysis of a specimen made by Mr. Trippel, although the amount of sulphur is evidently too low. He found:

Lead,	23·31	or	Galena,	26·93
Silver,	0·21	"	Silverglance,	0·24
Copper,	56·10	"	Copperglance,	70·26
Iron,	1·50	"	Pyrites,	3·20
Sulphur,	18·66			
	99·78			100·63

This composition corresponds, nearly, with the formula $4Cu_2S + PbS$, which requires 58·08 copper, 23·59 lead and 18·33 sulphur. The composition of F. Field's *alisonite* is $3Cu_2S + PbS$ and that of the *cuproplumbite* $Cu_2S + 2PbS$. I have no specimens of either of these minerals for comparison. May they not also prove to be pseudomorphs of copper-glance after galena in a yet unfinished condition?

5. *Millerite.*

A beautiful variety of *millerite* occurred lately in considerable quantities at the Gap Mine, Lancaster county, Pa., forming coatings of a radiated structure of $\frac{1}{16}$ to $\frac{1}{4}$ of an inch in thickness or concentrically radiated semi-globular masses or tufts. It is frequently tarnished, and many pieces show a commencing alteration into copperglance. Such specimens are dull, of a black color at the upper part of the tufts or little crystals, while the lower still presents the brass-yellow color and metallic lustre of the millerite. Analyses made in my laboratory, gave for:

I. *The purest millerite.*				II. *The partly altered millerite.*			
Sulphur,	35·14			Sulphur,	33·60		
Copper,	0·87	or	Cu_2S 1·09	Copper,	4·63	or	Cu_2S 5·80
Nickel,	63·08	"	NiS 97·29	Nickel & Cobalt,	59·96	"	(NiCo)S 92·48
Cobalt,	0·58	"	CoS 0·89	Iron,	1·32	"	FeS 2·07
Iron,	0·40	"	FeS 0·63	Insoluble,	0·54		
Insoluble,	0·28						
	100·35		99·90		100·05		100·25

6. *Proustite* (?)

The very rich silver ore tetrahedrite (?) described by me (this Jour., [2], xvi, 83) has been found by some late explorations at McMakin mine, Cabarras county, N. C., apparently in considerable quantities. I had an opportunity to examine a great number of specimens and have observed on a few of them, besides native silver, microscopic crystals of a bright cochineal red color, which appear to be *proustite*. Although the quantity is too

small for any further examination, I considered this occurrence interesting enough to have it recorded. Associated species are, besides those already mentioned, galena, blende, pyrites, talc, quartz, diallogite, calcite, barytes, etc.

7. *Automolite.*

The beautiful automolite from the Canton Mine was first noticed by Prof. C. U. Shepard (Report on the Canton Mine, Savannah, 1856, and 2d edit., New Haven, 1856.) The crystals are of a very deep leek-green color and vitreous lustre, and present the octahedral and dodecahedral planes, the latter very deeply striated, parallel with the macrodiagonal. An examination made in my laboratory gave:

			Oxygen.	
Silicic acid, (quartz)	2·37 p. c.			
Cupric oxyd,	1·23 "			
Alumina,	53·37 "	contains	24·95	26·95 = 3
Ferric oxyd,	6·68 "	"	2·00	
Ferrous oxyd,	3·01 "	"	0·67	
Zinc oxyd,	30·27 "	"	6·97	8·97 = 1
Manganous oxyd,	0·20 "	"	0·04	
Magnesia,	3·22 "	"	1·29	
	100·35			

The small percentage of silicic acid in the above analysis results from a mechanical admixture of quartz; the cupric oxyd probably does not belong to the mineral and therefore has not been considered so; taking the iron as magnetic oxyd, which is most rational on account of the deep leek-green color, we get exactly the spinel formula $RO : R_2O_3 = 1 : 3$.

8. *Pyrope.*

A deep blood-red, and sometimes brownish-red variety of pyrope was several years ago brought from near Santa Fé, New Mexico. It forms small, somewhat angular grains, of from $\frac{1}{8}$ to $\frac{1}{4}$ of an inch in size, the edges rounded as if worn off. Sp. gr. at 12° C. =3·738. An analysis made in my laboratory gave:

			Oxygen.	
Ignition,	0·45			
Silicic acid,	42·11	contains	20·86	
Alumina,	19·35	"	9·04	9·85
Chromic oxyd,	2·62	"	0·81	
Ferrous oxyd,	14·87	"	2·30	
Manganous oxyd,	0·36	"	0·08	9·47
Lime,	5·23	"	1·49	
Magnesia,	14·01	"	5·60	
	99·00			

Considering in this analysis the chrome as chromic oxyd, and the iron as ferrous oxyd, we get for this pyrope the garnet formula: $3\dot{R}_2\ddot{S}i + \ddot{R}_2\ddot{S}i_3$, the oxygen ratio being nearly = 1 : 1 : 2.

9. *Lime-Epidote.*

The minerals presented to me by Alex. Trippel, Esq., contained an interesting variety of epidote from the Polk County Mine, East Tennessee. It occurs in large but indistinct crystals, which are lengthened parallel to *ii*, which plane is best developed and can be distinctly observed on every crystal; some of the crystals show also the planes $1i$ and $\frac{1}{2}i$, but the two latter generally are obliterated, and generally can be recognized only by a deep striation. The cleavage is very distinct parallel with *ii*. The color is grey, with a blueish greenish or greenish brown tint. Their sp. gr. at 12° C. = 3·344. Frequently, especially the larger crystals, intermixed with chalcopyrite and pyrites, and quartz. I found them to contain:

Ignition,	....	0·71
Silicic acid,	39·73	40·04
Alumina,	....	30·63
Ferric oxyd,	....	2·28
Manganous oxyd,	....	0·19
Lime,	....	25·11
Magnesia,	....	*trace*
Cupric oxyd,	....	0·24
		99·20

Another variety in aggregations of coarse grained, confusedly crystalline, sometimes columnar masses of a greyish white color, has evidently undergone a partial decomposition; it is associated with blende, harrisite, garnet, etc. Mr. Trippel has communicated two analyses, I. by fluohydric acid, II. by fusion with carbonate of soda. He obtained:

	I.	II.
Silicic acid,	....	43·20
Alumina,	29·08	29·60
Ferric oxyd,	2·73	2·88
Magnesia,	0·60	0·56
Lime,	23·93	22·72
Ignition,	0·26	0·26
Potash,	*traces*	
		99·22

10. *Leopardite, a true porphyry.*

This peculiar feldspathic rock, which occurs in the neighborhood of Charlotte, Mecklenburgh county, N. C., and first noticed by Prof. C. U. Shepard as the leopard stone of Charlotte, and by C. L. Hunter, (this Journal, [2], xv, 377,) has also been observed at other localities; for instance, near the Steele Mine, Montgomery county, N. C. According to Prof. Shepard, it is a compact feldspar and quartz, the spots being produced by iron and manganese. I have made an examination of it, which proves it to consist of a feldspathic matrix and disseminated through it minute crystals of a feldspar, apparently orthoclase, showing rectangular cross-sections, and six-sided double pyra-

mids of quartz, thus having the petrographic character of a true porphyry, a conclusion which was confirmed by analysis.

The matrix, which was carefully selected for examination, had a crypto-crystalline structure, only visible with the aid of a lens, and a very faint silky lustre. Color, yellowish white. Some portions scratched orthoclase, others did not, notwithstanding the material appeared to be quite homogeneous. The purest that could be selected contained as follows:

Silicic acid,	75·92
Alumina,	14·47
Ferric oxyd,	0·88
Magnesia,	0·09
Lime,	0·02
Soda,	4·98
Potash,	4·01
Ignition,	0·64
	100·01

It will be observed that the composition of Bunsen's normal constitution of trachyte, to which the porphyries belong, closely resembles the above, containing:

Si	Al, Fe	Ca	Mg	KNa
76·67	14·23	1·44	0·28	7·38

11. *Staurotide?*

I have examined the mineral, that Prof. C. U. Shepard, in his Report on the Canton Mine, first noticed as Staurotide or supposed Partschine, and of which Prof. W. J. Taylor found a new locality near Webster, Jackson Co., N. C. (Proc. Ac. Nat. Sc. of Phil. Aug. 1858) and of which he remarks that an examination made by Dr. Genth and himself renders it very doubtful as to its being staurotide. I have since made several analyses of quite pure material, using the utmost care to obtain *perfectly correct* results.

It occurs in minute crystals, rarely of $\frac{1}{4}$ of an inch in length, of a yellowish brown or cinnamon brown color, apparently right rhombic prisms, similar to those of staurotide with the planes *I* and *ii*. I have not observed any others. Sp. gr. at 27° C. = 3·792.

Associated with the copper and lead ores of the Canton Mine, and very characteristic for this locality. I obtained:

	I.	II.	III.	IV. Mean result.	Oxygen.		
Ignition,	1·91	1·25	1·25	1·47			
Silicic acid,	28·72	28·87	28·88	28·82	contains	14·96	15·29 = 5·60
Titanic acid,	0·88	0·94	0·70	0·84	"	0·33	
Alumina,	49·02	49·42	49·20	49·21	"	23·00	25·85 = 9·47
Ferric oxyd,	9·34	9·64	9·55	9·51	"	2·85	
Zinc oxyd,	6·49	7·41	7·66	7·13	"	1·41	2·73 = 1
Manganous oxyd,	not det.		0·15	0·15	"	0·03	
Magnesia,	3·19	3·29	3·17	3·22	"	1·29	
Cu Ag,	*traces*	*traces*	*traces*				
	99·55	100·82	100·56	100·35			

Considering the bases RO to be combined with alumina in the proportion in which they form spinel, we would have 28·60 per cent of this aluminate. This would leave 14·81 oxygen of the alumina, which with 2·85 of the ferric oxyd are in the ratio of 5 : 1, as in most of the staurotides. The oxygen ratio of the remaining bases R_2O_3 to SiO_2 (TiO_2) is = 6·47 : 5·60 = 1·14 : 1. The formula for the above mineral would nearly resemble: $2\dot{R}\,\dot{R}l + \dot{R}l_4Si_5$.

It may be interesting to state that calculating in Jacobson's analyses of the Polewskoi staurotide the magnesia as being combined with alumina, we would obtain from 8·67 to 8·82 per cent of aluminate, and the oxygen ratio of the remaining bases R_2O_3 and SiO_2 would be as 1·18 : 1 and 1·15 : 1 or nearly the same as in the Canton mineral.

Jacobson's other analyses, calculated in the same manner, give different results, and after deducting the magnesia as aluminate, we get for the bases R_2O_3 and SiO_2 in the Brittany mineral the ratio 1·23 : 1, in that from Airolo near St. Gothardt, 1·48 and 1·42 : 1, and in that from St. Gothardt from 1·88 to 1·62 : 1.

The difficulties in the analysis of staurotide, especially with regard to the quantity of silicic acid and the separation of the bases RO from those R_2O_3, and the doubts existing as to the state of oxydation of the iron and manganese, render it very desirable to have this mineral re-investigated. Not before a *series* of the most careful analyses of the different varieties of pure staurotide have been made, can the true constitution of this species be established.

12. *Chrysolite and minerals resulting from its alteration.*

Chrysolite, or especially the variety which is known as olivine, has for a long period of time been observed as occurring *only* in basalt or lava or rocks of a similar origin. Since the important discovery of the well known pseudomorphs of serpentine after chrysolite, at Snårum, in Norway, sometimes having still a nucleus of the latter, it has been found at several localities in talc slate, at Sissersk and other places, and in Siberia, (glinkite) and a titaniferous variety at Pfunders in Tirol.

I have lately received several specimens from a new locality, from Webster, Jackson county, N. C., and an examination of them appears to give evidence that chrysolite is probably the mineral from which talc slate and many of the serpentines have been formed.

I have two varieties from there, (I) a pale, greyish green one, of granular structure (the largest grains not over two lines long, but generally very minute) and very friable, and (II) another less friable, of a somewhat darker yellowish olive green color. Sp. gr. of I. at 12° C. =3·280, of II. =3·252.

In talc slate probably belonging to the lower Silurian formation, associated with small octahedra of chromic iron, and a peculiar mineral, resembling pyrosclerite and serpentine. The analyses gave:

	I.	II.	
		a.	*b.*
Ignition,	0·82	0·50	0·76
Chromic iron and quartz,	0·58	1·27	1·83
Silicic acid,	41·89	40·87	40·74
Ferrous oxyd,	7·39	7·39	7·26
Nickel oxyd,	0·35	0·50	0·39
Magnesia,	49·13	not det.	49·18
Lime,	0·06	not det.	0·02
Alumina, oxyds of cobalt, and manganese,	*traces*	*traces*	
	100·21		100·18

Even the purest specimens show here and there a few specks of talc and a chloritic mineral, both of which evidently result from the alteration of chrysolite; where the talc increases in quantity it forms first slender crystalline masses, like spears passing in all directions through the olivine; where it predominates the remnants of the olivine can frequently be observed in little patches or nodules or between the greenish white laminæ of the talc, generally having lost the vitreous lustre, and where it is in immediate contact with the talc, more or less tinged yellowish or brownish from a minute quantity of hydrated ferric oxyd, resulting from the oxydation of the ferrous oxyd of the chrysolite. An analysis of the talc gave:

Water,	0·34
Silicic acid,	64·44
Alumina,	0·48
Ferrous oxyd,	1·39
Nickel oxyd,	0·23
Magnesia,	33·19
	100·07

Not only talc, however, results from the alteration of the chrysolite, but also a mineral, which in its physical properties, as far as they could be ascertained, resembles pyrosclerite. It appears to be rhombohedral; the crystals although indistinct present triangular basal and also rhombohedral planes. The cleavage is basal and highly perfect. H. = 2·5. Color, dark blueish to brownish green; translucent. B.B. it exfoliates slightly and becomes silver-white. Infusible. The material for analysis was too small to have it of a uniform color. The results were as follows:

	I.	II.	Mean.		Oxygen.	
Ignition,	3·29	not det.	3·29	contains	2·92	= 0·15
Silicic acid,	31·15	31·75	31·45	"	16·33	= 0·9
Alumina,	13·70	12·45	13·08	"	6·11	7·39 = 0·4
Chromic oxyd,	4·16	not det.	4·16	"	1·28	
Ferrous oxyd,	4·83	4·94	4·88	"	1·08	
Nickel oxyd,	0·16	not det.	0·16	"	0·03	
Magnesia,	not det.	43·10	43·10	"	17·23	18·40 = 1
Lime,	0·17	not det.	0·17	"	0·05	
Potash,	not det.	0·06	0·06	"	0·01	
			100·35			

Although the results of the two analyses agree pretty well, and are believed to be correct, I hesitate to express an opinion on this mineral. The composition corresponds nearly with the formula: $3\dot{R}_3\ddot{R}l+3\dot{R}\ddot{S}i+\dot{H}$. It is to be hoped that soon larger quantities of this interesting mineral may be obtainable for a more complete investigation.

It is worthy of remark that the oxygen ratio of SiO_2 and RO is nearly as in the original chrysolite, and the bases R_2O_3 : HO nearly as 3 : 1, as in diaspore.

Another product resulting from the decomposition of this chrysolite is serpentine of a dark greenish grey color, resembling the duller varieties of the so-called *williamsite* of Wood's mine, Lancaster county, Pa. I have no specimens showing the *gradual* change from the chrysolite; it still shows however to some extent the granular structure of the same and here and there little lustrous specks, where formerly the larger grains of it existed. Examined with a good lens some of the grains have a vitreous lustre and appear to be unaltered chrysolite. Small grains of chromic iron are also intermixed with it. An analysis gave:

			Oxygen.	
Ignition,	9·55	contains	8·49	= 1·5
Chromic iron,	0·57			
Alumina,	0·31			
Nickel oxyd,	0·27	"	0·06	
Ferrous oxyd,	7·17	"	1·59	17·09 = 3
Manganous oxyd,	*trace.*			
Magnesia,	38·62	"	15·44	
Lime,	0·02			
Silicic acid,	43·87	"	22·78	= 4
	100·88			

The formula is: $2(\dot{R}_3\dot{S}i_2)+3\dot{H}$ or $\frac{1}{4}$ water less than usual.

In the change of chrysolite into talc or serpentine a portion of the magnesia is eliminated, which separates either as brucite, hydromagnesite, magnesite or dolomite, minerals which occur more or less at the principal serpentine localities. I have not received either from North Carolina and know nothing of their occurrence. The serpentine regions of Maryland, Pennsylvania,

New Jersey, New York, Connecticut, Vermont and the other New England States, as well as Canada, do not appear to have furnished any unaltered chrysolite. I frequently have had an opportunity to examine the so-called "sand chrome ores" from Maryland and Pennsylvania from almost every locality, but in not a single instance have I observed the least indication of chrysolite. The only sample in which I found very fine grains or conglomerations of minute grains of this mineral of a yellowish olive green color, in appearance almost exactly like that from North Carolina, came from Loudon county, Virginia, in the neighborhood of the city of Washington.

By the numerous very careful analyses of T. S. Hunt,* of American serpentines, a very important fact, the existence of two varieties, has been established; the first containing both nickel and chrome, and the other being entirely free from either of these metals. From my own observation it seems that the latter result from the alteration of pyroxenic and amphibolic minerals. It is a question of great interest whether the nickeliferous and chromiferous talcs and serpentines may not all have the same origin and result from the decomposition of chrysolite? I do not know a single fact which speaks against this suggestion.

If we assume the nickeliferous or chromiferous talc slates and serpentines to owe their existence to chrysolite, this mineral must in the earlier days of our planet have been very plentiful, and this fact in connection with some ideas of Gustav Bischof on the origin of olivine (Lehrbuch der chem. und phys. Geologie, II, 1, 676–685. Bonn, 1851,) renders the occurrence of specimens, showing the *direct change* of it into talc, etc. of great scientific interest. After having shown that the olivine in the basalts and lavas cannot have been eliminated from the constituents of the molten rocks, but must have pre-existed in its present condition, before it was intermixed with them, he remarks: "*The question whether the olivine which is brought up by the lava comes from unknown rocks*, or whether it is an exclusively volcanic product, we must leave undetermined."

This is certainly a very important question. The occurrence in strata belonging probably to the lower Silurian, does not admit of its volcanic origin, and the facts established by the above observations leave no doubt in my mind that the *chrysolite* or *olivine-rock*, which formerly must have existed in large strata or masses, has furnished the material for the globular masses and grains of this mineral, found in the basalts and lavas, which is made the more probable since almost all the chrysolites analyzed since Stromeyer, have been shown to contain nickel, and, according to Walchner, chrome not less generally disseminated through

* In T. S. Hunt's paper on Ophiolites, this Journal, [2], xxvi, 239, line 30, read chrysotile for chrysolite.

them, the latter certainly as chromic iron, which I have observed with a good magnifier in exceedingly fine particles or even in minute octahedra of the characteristic greasy sub-metallic lustre in olivines from numerous localities. B.B. they give distinctly the chrome reactions.

13. *Serpentine.*

In connection with the preceding paragraph, I will mention a few observations of serpentines, resulting from the alteration of other minerals, which lately have come to my notice.

In my collection I have specimens of fibrous serpentine from Texas, Lancaster county, Pa., of a greenish white color. The fibres are about 1½ inches long and separate very easily. It has no lustre, and evidently results from the alteration of asbestos; a chemical examination proves it to be pure serpentine.

The so-called "baltimorite" is certainly nothing else but a pseudomorph of serpentine after asbestos.

A specimen of chrysotile with silky lustre and a greenish, brownish and greyish white color, the fibres from three to four inches long from Providence Township, Delaware county, Pa., also originates from asbestos, which, of exactly the same structure, is still found in the neighborhood.

Another piece of chrysotile from Marble Township, Del. county, Pa., was formerly bronzite. It consists of small roundish masses of ¼ to ½ of an inch in diameter, imbedded in massive dark blackish green serpentine, the fibres corresponding with the former cleavage separation of the bronzite. Its color is greyish-brownish-greenish white, and the lustre silky.

In the same township is found chrysotile resulting from the alteration of actinolite; it is of a greenish white color and somewhat silky lustre, shows still the divergent structure of the original mineral. It is imbedded in massive, somewhat granular, greyish green serpentine, in some places of a darker color from the admixture of exceedingly fine grains of magnetite, evidently another product of the decomposition, which has taken place.

The well known foliated variety, the "*marmolite*," results according to the observations of Prof. Geo. J. Brush and myself, from the alteration of brucite into serpentine.

With regard to fibrous serpentine or chrysotile, I was for a long time in doubt, whether it might not be an original mineral, I mean one crystallized *as such*—but all the above observations and the mode of its occurrence appear to show conclusively that, like all the other serpentines, it is the result of the alteration of other minerals.

14. *Kerolite.*

A milk-white inclining to blueish-white kerolite, with waxy lustre, from Harford county, Md., which I have examined in my laboratory contains:

	I.	II.	III.
	By sulphuric acid.	By carbonate of soda.	
Water,	not det.	20·91	not det.
Silicic acid,	51·20	51·09	51·02
Ferrous oxyd,	0·22	0·23	0·26
Magnesia,	26·81	28·28	27·91
		100·51	

15. *Monazite.*

One crystal of this rare mineral has been found in the gold washings of Todd's branch, Mecklenburgh county, N. C., associated with diamond, garnet and zircon, the latter similar in form to those of McDowell Co., N. C. (Dana's Mineralogy, 4th edit., page 195, fig. 386.)

It is $\frac{1}{4}$ of an inch long, a little over $\frac{1}{8}$ wide and somewhat less than $\frac{1}{8}$ thick, of a yellowish brown color and shows distinctly the following planes: 1, 1*i*, *ii*, *I*, –1 and *i*. The crystal being slightly waterworn has the edges somewhat rounded, by which some others may have been obliterated. The sp. gr. at 12° C. =5·203.

16. *Rammelsberg's Mineralchemie.*

It is with great regret that I feel it my duty to investigators to call their attention to several omissions and misapprehensions in Rammelsberg's great work, "Mineralchemie," which I consider of too much importance to be allowed to pass unnoticed. Not intending to write a criticism of the work itself, I will limit my remarks to those investigations only, which have been made in my laboratory either by myself or under my immediate supervision.

On page 5, under *Tellurwismuth* he gives the analyses of "*C. Selen-Tellerwismuth*," made by Coleman Fisher (this Journal, [2], vii, 282) and states that the great variety of the Virginia mineral is somewhat surprising. If Prof. Rammelsberg had read my paper (this Journal, [2], xix, 15) he might have found that I *distinctly* state, that the material for my analyses was *a portion* of the *same*, which Fisher examined, and his analyses being erroneous, that a selen-tellurwismuth with such a high percentage of selenium *does not exist.*

On page 21, he gives Shepard's old analysis of chathamite (cloanthite), which was made before any exact mode of separation of cobalt and nickel was known, and in a note he adds my recent analyses.

On page 50, he states that according to Pratt the harrisite is the dimorphous form of the subsulphid of copper, whilst the credit for this suggestion is certainly due to Prof. Shepard. The above analyses, under No. 4, I hope will satisfy Prof. R. as well

as others of the correctness of my views that harrisite as well as cantonite are pseudomorphs after galena.

On page 177, he gives the analyses by myself (8) and Whitney (11) of the variety of pitchblende, which LeConte had distinguished as coracite, and at No. 11 with a mark of interrogation he says: "whether identical with No. 8," although in my paper (this Journal, [2], xxiii, 421) I speak of it as the *same* mineral.

On page 425, my species "barnhardtite" figures amongst the minerals of which the composition is but incompletely known, notwithstanding the numerous analyses of this mineral from several localities, all agreeing very well with the formula given, and the fact that my results have been corroborated by an analysis of O. Dieffenbach (Liebig and Kopp's *Jahresbericht*, 1854, 810). No doubt can exist as to this species. This opportunity offering I may add a new locality, the Cambridge mine, Guilford Co., N. C., and state that an analysis of it gave results corresponding with those previously obtained.

On page 228, he gives my analysis of the herrerite or cupreous smithsonite, saying that the mineral in which Herrera alleged to have found tellurium, carbonic acid and nickel-oxyd, had been *correctly* determined by Del Rio; this is true as far as the principal constituents are concerned, but Del Rio called it a "*nickeliferous*," whilst it is a *cupriferous* smithsonite; on page 429, we find herrerite again under the *doubtful* species—and to make it still more doubtful, Rammelsberg says with a mark of interrogation, that I consider it a cupriferous smithsonite. It may well be questioned whether Rammelsberg or any other chemist has the right to speak authoritatively on a subject, upon which he has had no opportunity to inform himself autoptically or by chemical investigation. My analyses are of course open to re-examination by any chemist, provided he uses the same material upon which I operated and equal care, and criticisms based on *such* re-examinations are perfectly justifiable. But wherever that has not been done, I earnestly protest against an author casting a shadow of doubt over my investigations, when I know that all pains have been taken to furnish reliable information. Where a doubt exists, I make frequent use of an interrogation mark: a compiler, if he intends to make his work a reliable one, has no more right to omit this query, where an author has considered it necessary, than to add one without stating obvious reasons for so doing.

On page 632, he says that we have no crystallized feldspar of a higher amount of acid than orthoclase, and "baulite" is mentioned on page 638 as containing minute crystals of feldspar, apparently on my authority. I am not aware that I ever made such a statement. It is certainly a grave misapprehension of my investigation (Ann. der Chem. und Pharm., lxvi, 270). This

is the more surprising from the fact that Prof. J. D. Dana has at my request examined a specimen with the microscope, but could not detect any admixture of quartz, and that it consisted of quite small glassy crystals or grains, which appeared to be purely the *baulite* (1st Suppl. to Dana's Mineralogy, this Journal, [2], xix, 356). Baulite *is a crystallized feldspar* with the oxygen ratio of $\dot{R} : \ddot{R} : Si = 1 : 3 : 24$.

On page 1019 he remarks that the zamtite, a hydrocarbonate of nickel from Spain is probably *identical* with nickel-gymnite (*a silicate*); it is more likely identical with emerald-nickel.

Amongst the omissions I notice the analyses of the meteoric iron from New Mexico, the nickel meteorite from Octibbeha, Miss., platinum from Oregon, orthoclase from N. C., etc. etc.

Philadelphia, Nov. 30th, 1861.

ART. XX.—*On some questions concerning the Coal Formations of North America. Families, Genera and Species of Coal Plants of the United States;* by LEO LESQUEREUX. (Continued from vol. xxxii, p. 205.)

Pecopterideæ.

IF we continue to follow Brongniart's principle for the classification of the fossil ferns, attempting to fix the divisions *from the nervation, in relation with the general form of the fronds and of the pinnules*, the tribe of the *Pecopterideæ* and its generic sections appear fixed by reliable and sufficient characters.

The *Pecopterideæ* have a bi- or tri-pinnatifid frond with unequal, open pinnæ and equal, oblong or linear-obtuse pinnules, generally united together near the base and thus attached to the rachis by the whole enlarged, sometimes decurrent, very rarely narrowed base. The medial nerve is strong, straight, generally ascending to the top of the leaflets, and the veinlets are either straight and perpendicular to the medial nerve, simple or forking once or twice, or somewhat oblique, arched and dichotomous. The fructification is apparently punctiform; sometimes marginal and continuous as in the genus *Pteris*.

This definition is, with slight modification, that of Prof. Brongniart. Though the last remark about the fructifications has been generally repeated by European authors, I do not know of any species of *Pecopterideæ* that has been seen with evident marginal fructifications. The likeness of form and nervation of some of our fossil species of the coal-measures with species of *Pteris* living at our time is undeniable; but it is the only reason we have to suppose that their fructification may be sometimes marginal. If species of this tribe were found with evident mar-

ginal fructifications, they should be at once separated and put into a peculiar division.

The *Pecopterideæ* that by their general form and nervation most resemble the genus *Pteris* constitute a separate group. Generally larger than the other species of the tribe, their fronds are broad at the base, lanceolate pointed in the upper part, nearly triangular in outline. The lower pinnæ are bi-pinnately or pinnately divided with long-linear obtuse, rarely somewhat acute leaflets, while the upper pinnæ become pinnatif and then simple with shorter and broader pinnules. Thus the fronds in the lower part are bi- or tri-pinnately divided while the upper part is only bi-pinnately or even pinnately parted. The strong medial nerve of the leaflets ascends to the point and the nervules generally perpendicular to the medial nerve, or nearly so, are strongly marked and simple or forked once.

The name of *Alethopteris* given to this division by Sternberg and Göppert has been admitted by Brongniart; and the section itself considered by this author as forming a well characterized genus, provided it be restricted to species agreeing with the above definition and not extended beyond its limits, as has been done by Unger. The known American species belonging to this genus are: *Alethopteris lonchitidis* Sternb., *A. aquilina* Göpp., *A. Serlii* Brgt., the largest of our species with pinnæ sometimes longer than one foot and pinnules two inches long; *A. marginata* Brgt., very rare indeed and perhaps not even belonging to our coal-measures, the specimen referred to this species being obscure and incomplete. These four species are common to both continents. As exclusively American species we have: *Alethopteris Pennsylvanica* Lsqx., *Alethopteris species nova*, (ined:) formerly referred to *A. urophilla* Brgt., (Penn. Geol. Rep., p. 864) but differing by twice forked veins and by a broader, shorter and pointed terminal pinnule. *Alethopteris Owenii* Lsqx., (Ark. Geol. Rep., vol. ii, p. 309, pl. 2, fig. 1), *A. Coxiana* Lsqx., (Ky. Geol. Rep., vol. iv, ined:) and *A. distans* Lsqx., if this species founded on two small and imperfect specimens proves to be a good one. Our *A. Coxiana* Lsqx., somewhat resembles *A. sinuata* Brgt. Its secondary veins are more oblique than those of any other species of the genus. It is thus intermediate between this and the following division.

The genus *Callipteris*,* proposed by Brongniart for another group of fossil ferns, is related to the *Neuropterideæ* by the nervation, and to the *Pecopterideæ* by the leaflets attached to the rachis by their whole base and generally united together. Prof. Göppert formerly referred the species of this group to a peculiar section of *Neuropteris*, and I admitted the same views in the

* This name Callipteris is given also by Mr. John Smith to a genus of living ferns (Hook. Mem. on the Geol. of Great Brit. p. 410).

Pennsylvania report. But this last genus is far more natural if preserved with this characrer: (*leaflets attached to the rachis by the middle of their base or by the base of the medial nerve only*); and the group of species forming the genus *Callipteris* find also a more natural place as the first of the *Pecopterideæ*, serving for a link of union between this and the *Neuropterideæ*.

In comparing the species referable to the genus *Callipteris* Brgt., it is evident that they present two somewhat different types of nervation and thus should be separated in two sections. The one characterized by a thick straight medial nerve, ascending above the middle of the leaflets and by thin, close, arched, dichotomous forking veinlets, is more closely related to *Neuropteris;* the other with a thinner, somewhat flexuous medial nerve, dichotomously forking in ascending and veinlets oblique, a little arched, distant and forking only once or twice, is related to *Odontopteris*. Of European species: *Pecopteris gigantea* Brgt., *P. punctulata* Brgt., *Neuropteris conferta* Göpp., and *N. obliqua* Göpp., (four species extremely alike and perhaps identical). *Pecopteris sinuata* Brgt.,* *Neuropteris* (*Pecopteris* Brgt.) *ovata* Germ., are referable to the first section of this genus with a single American species: *Callipteris Sullivantii* Lsqx.† In the second section represented in the coal-measuaes of Europe by *Neuropteris conjugata* Göpp., I would place our *Neuropteris Moorii* Lsqx., *N. adiantites* Lsqx., and *Alethopteris rugosa* Lsqx. This last species was formerly described and figured from very incomplete specimens first as *Ale-*

* No good good specimens of these species have been thus far found in our coal measures. The specimen from Pennsylvania, referred to the last species, is indistinct.

† It is on the stems and leaves of this species that the small body, *Gyromices Ammonis* Göpp., alluded to in a former paper (No. 95, page 105 of this Journal), is especially found in the coal-measures of Illinois. Since the publication of my former paper where this species is considered as a small freshwater shell, I have received from Prof. J. W. Dawson of Montreal a kind note on this subject, with specimens showing that the Nova Scotian species is the same as ours. He says: "This species *Spirorbis carbonarius* formerly *Microconchus carbonarius* abounds in the Carboniferous rocks of Nova Scotia, occurring in the lower coal-measures under the Carboniferous limestones and thence up to the upper Coal-measures. It is usually found attached to the leaves and stems of land plants or to shells of the Univalve and Modiola-like Mollusks of the Coal-measures (*Naiachites* Daw.). A similar species is found in the Devonian at Gaspé and St. Johns, New Brunswick, attached to land plants. I first observed this shell in 1844 and noticed it as a *Spirorbis* (Journ. of the Geol. Soc. of London, vol. i, 1845). Mr. Binney referred the British shell to *Spirorbis* in 1852. In 1853 I noticed the resemblance of the Nova Scotian to the British species (Journ. of the Geol. Soc., vol. x) and in my Supplement to Acadian Geology, have stated my belief in their identity, (Acad. Geol., p. 147, Supl. p. 43)." As I formerly stated, it is certain that *Gyromices Ammonis* of the German authors is the same species as ours, and from Prof. Dawson's specimens it is evident also, that his *Spirorbis carbonarius* of Nova Scotia is identical with it. The remarks of the distinguished Professor establish beyond a doubt that the species is a shell. Judging from the figure in Acadian Geology, p. 147, that shows the mouth of the spirorbis as being cut in an undulating line, and especially from Lyell's figure (Manual of Geol., p. 525), I supposed that the Nova Scotian and the English species were different from ours whose mouth is exactly oval, with a thick obtuse margin. If Lyell's figure is exact, I think still that it cannot represent the same species as ours.

thopteris obscura, in the Penn. Geol. Rep., (p. 865, pl. 1, fig. 13 and 14) representing the upper part of a pinna, and later as *Alethopteris rugosa* in the Catalogue of fossil plants of the coal-measures of America (p. 11, tab. 1, fig. 2 and 3) showing only the lower part of a separate pinna. But better and more complete specimens of this fine species have since been obtained presenting its different parts. Like the other species of *Callipteris*, it is by the general outline of its frond and the form of its divisions a true *Alethopteris*, while its nervation is that of a *Neuropteris*. It has a tripinnately divided frond, with open, flexuous, ovate-lanceolate primary pinnæ and linear secondary pinnæ. The pinnules, united together up to the third of their length, are ovate-oblong, entire, somewhat obtuse, with a deltoid, obtusely pointed terminal pinnule. The lower and inferior pinnules are sometimes of an abnormal form or a little broader and more obtuse and as the upper pinnæ are decurrent on the rachis, they often become attached to the main stem. The medial nerve is thin, flexuous, forking in ascending (dichotomous) and the veinlets somewhat distant are oblique, arched and forked once or twice. Our *Alethopteris Sullivanti* Lsqx., has not yet been found with pinnæ attached to the rachis and it is still uncertain if these are decurrent as in the other species. In *Neuropteris Moorii* Lsqx., and *Neuropteris adiantites* Lsqx., this character is well marked and the main rachis is winged by decurrent leaflets.

I consider as a third well established division of the *Pecopterideæ* of the coal, the genus *Pecopteris* Brgt., as it is fixed in the following definition slightly modified from Brongniart, in his *Tableau des Genres*, page 24. Frond bi-tripinnatifid; pinnæ long, pinnatifid, with pinnules attached to the rachis by their whole base, generally united together at the base, oblong, obtuse, entire, equal, not decurrent. Medial nerve thick or well marked; veins oblique or perpendicular, simple, once, twice, rarely thrice, forked.

The modification of Brongniart's definition concerns only the characters taken from the form of the pinnules: oblong, entire, obtuse, and equal; permitting the grouping of the species of our coal-measures in a more simple and natural way. The only species that apparently differs from these characters is *Pecopteris arguta* Sternb., whose leaflets are sometimes sharply serrate. As will be seen below, this fossil fern has its pinnules sometimes entire, and thus the serrature of part of the leaflets may be considered as abnormal.

Prof. Brongniart in his *Tableau des Genres* has farther subdivided the genus *Pecopteris* into three subgenera, according to the direction and the number of the divisions of the veins. As these characters are not always permanent in the same species, these

subdivisions can be preserved for convenience sake only. They are:—

§ 1. *Aplophlebis.* *Pecopteridis* species with straight medial nerve and secondary veins simple, oblique or perpendicular to it. As belonging to our coal-measures, we have in this section: *Pecopteris arguta* Brgt., *P. unita* Brgt., *P. acuta* Brgt., *P. æqualis* Brgt., *P. concinna* Lsqx., *P. arborescens* Brgt., *P. cyathea* Brgt., *P. affinis* Brgt., *P. pusilla* Lsqx., *P. dubia* Lsqx., and *Asplenites rubra* Lsqx. These last five species may be varieties of *P. arborescens*, or at least are considered as such by some authors. To this section, I would still add: *Pecopteris longifolia* Brgt. and its identical species *Diplaxites emarginatus* Göpp.

§ 2. *Dicrophlebis:* containing species with twice or thrice forked veins. Our American species agreeing with it are: *Pecopteris oreopteridis* Brgt., *P. pennæformis* Brgt., *P. plumosa* Brgt., (identical with *P. dentata* Brgt.), *P. villosa* Brgt., and *P. decurrens* Lsqx.

To the third subgenus *Cladophlebis* Brgt., with pinnules sometimes free at the base, nervules more oblique on the medial nerve, more divided, generally arched and dichotomous, we could refer as species from our coal-measures: *Pecopteris Cistii* Brgt., *P. polymorpha* Brgt., *P. distans* Lsqx., *P. Sheafferi* Lsqx., and perhaps *P. velutina* Lsqx., whose nervation is entirely obsolete and unknown.

A number of species of *Pecopterideæ*, especially belonging to our coal-measures, should, I think, from their peculiar appearance, be grouped together in a separate genus. They are all thick-leaved ferns, and their pinnules though mostly entire have a tendency to become irregularly lobed, when they increase in size, especially the lower and inferior one of each pinnæ. The pinnules are unequal in size and varied in form. They have a strong medial nerve, dichotomous or forking in ascending, generally straight and the secondary nerves or veins diverging in an acute angle and once or twice forked, according to the size of the pinnules. In this group, I would place *Pecopteris nervosa* Brgt., *P. muricata* Brgt., *P. Pluckneti* Brgt., *P. Loschii* Brgt., commonly found both in the European and the American coal-measures, with the following species belonging exclusively to ours: *Pecopteris Sillimani* Brgt., *P. callosa* Lsqx., (Ill. Geol. Rept. ined. pl. 3, fig. 1,) nearly related to *P. Loschii*, *Sphenopteris Lesquereuxii* Newb., scarcely distinguishable from *P. Sillimani*, and likely a variety of the same, *Sphenopteris Newberrii* Lsqx., and *Pecopteris dimorpha* Lsqx. This last species is related to *Pecopteris bifurcata* Sternb., referred by Prof. Geinitz to *P. Pluckneti*. The nervation and the form of some of the leaflets is the same, but it differs by peculiar and apparently persistent characters. The leaflets generally free at the base are sometimes distant and have a different form on each side of the pinnæ. The upper ones are shorter, broader, broadly obtuse at the top, variously and irregularly lobed,

enlarged and somewhat decurrent at the base; those of the lower side of the pinnæ are longer, lanceolate, mostly entire, slightly pointed and also a little decurrent on the rachis. In the upper pinnæ only the shorter, generally triangular, pinnules are apparently united at the base, at least continuous; but they preserve the same difference of form on both sides of the pinnæ, broadly triangular on the upper, longer lanceolate triangular on the lower side. This remarkable species, which comes from the coal-measures of Rhode Island, varies as much in its ramification as in the form of its different parts. On one specimen, showing the part of a frond, the pinnæ are alternate, distant, very oblique on the main rachis; on another, the alternate pinnæ, more than six inches long, are perpendicular to the rachis, and placed very close to each other. It is probable that this last part is that of a large, primary pinna, and that the first one shows the upper part of the frond. In that case the frond is tripinnate or even quadripinnately divided, the lobes or divisions of the pinnules being sometimes deep and regular on both sides.

The only one of our species that might appear out of place in this newly proposed group is *Sphenopteris Newberrii* Lsqx., especially from the peculiarity of its ramification. The leaflets also, though sometimes irregularly lobed, are less so than in the other species and the enlarged main rachis appear narrowly winged by the inferior decurrent pinnules like that of some *Sphenopteris*. Except this last character, which cannot be considered as generic, the essential features of this fern refer it to this group. Its nervation is nearly exactly like that of *Pecopteris nervosa* Brgt., though less deeply marked, and its pinnules unite near the base. The ramification also of *Pecopteris nervosa* and *Pecopteris Loschii*, is, if not dichotomous, at least forked at the upper part of the fronds, into two diverging branches as in the *Gleichenites* of Göppert. In *Sphenopteris Newberrii*, these branches are united in a more open angle at the top of an apparently naked pedicel in the form of an upturned crescent.

If, as I think, this peculiar group of fossil ferns of our coal ought to be separated as a genus, the name of *Aspidites* Göpp. would be appropriately preserved for it. It was formerly established by the author, in his Systema, p. 348, and afterwards abandoned, because, characterized as it was, especially by its fructification either known or supposed, it contained species that had not sufficient affinity to be grouped together. Nevertheless the definition characterizing the second section of this old genus would without hardly any modification agree with the species of the new one. Frond bi-tripinnate. Pinnules generally enlarged at the base, united, decurrent or separated and sessile; medial nerve somewhat flexuous, thinning upwards and becoming bifid at the upper end; secondary nerves emerging from it

in an acute angle, dichotomous; branches simple or forking, more or less arched. *Pecopteris Pluckneti* Brgt., was already placed in this section by Prof. Göppert, and some of the species appear nearly related to species of *Aspidium* of our time.

There are still some other species that have been placed by Brongniart in a separate section of the *Pecopterideæ*, named by him *Sphenopteroides*. These species are true *Sphenopteris*, and have been generally considered thus by European authors. Mr. Brongniart himself says, in his *Tableau des Genres*, that they would find perhaps a more natural and better place with the genus *Sphenopteris* than with the *Pecopterideæ*. We have only two American species referable to this section, and they are of course mentioned with the genus *Sphenopteris*.

It would be out of place to examine critically now the other genera proposed for the classification of the *Pecopterideæ*. A few only, on which our American specimens furnish some interesting data, can be mentioned here.

Göppert has separated his genus *Diplaxites*, especially from the pinnules united nearly in their whole length, and the medial nerve pinnately branching, with simple veinlets a little curved inwards and ascending to the margin of the leaflets. Mr. Bunbury, in his examination of some fossil ferns of Frostburg, Md., (Quart. Journ. of the Geol. Soc. of London, vol. 2, p. 82,) has made some very interesting remarks on this genus, referring to it as likely to be new, one of our American species. From numerous specimens collected in various parts of our coal measures it is evident, first, that our species and *Diplaxites emarginatus* Göpp., are identical, and secondly, that *Diplaxites emarginatus* Göpp., and *Pecopteris longifolia* Brgt., are also the same species. It is true that hitherto we have found this fossil fern only in pinnæ separated from the common rachis. But they are sometimes in great numbers on the same slate and both the broad-leaved and narrow-leaved forms, to which both names have been applied, are found mixed, together with those of an intermediate size, serving as transition. In some of the leaflets the inferior veins do not ascend to the top of the pinnules but diverging against the borders meet those of the contiguous pinnule half way, or below the point of union of the leaflets. In that case the species has exactly the nervation and the form of some pinnæ of the very variable *Pecopteris unita* Brgt. It is thus a true *Pecopteris*, perhaps identical with the last species.

The genus *Asplenites* Göpp., was separated from *Pecopteris* on account of the lengthened or linear fruit-dots. I formerly admitted it for one of our fossil ferns: *Asplenites rubra* Lsqx. But from the examination of a great number of specimens, it is evident that the narrow linear marks on the upper surface are mere irregular impressions from the fruit-dots, placed under the leaflets, varied indeed by contraction of the epidermis, and do not

show the real form of the dots. Both the linear and the round impressions are seen on the same specimens. Our species in this case is undistinguishable from *Pecopteris arborescens*. The *Asplenites nodosus* of Göppert has been also recalled to it by Geinitz.

In the genus *Polypodites* Göpp., still preserved by Unger, we find *Polypodites elegans* Göpp., when another species which appears to be identical with it, *Pecopteris arguta* Sternb., is left by the same author with the genus *Pecopteris*. The only difference that separates both species is that in the first, the leaflets are entire, and in the second evidently and sharply serrate. On some specimens of ours, both the forms are found on the same frond, viz., sharply serrate leaflets becoming entire either by the pressure of the teeth against the margin of the leaflets or by insensibly passing to an undulate and then to a perfectly smooth margin. The great and splendid specimens figured by Germar, of *Polypodites elegans*, are extremely like specimens of our *Pecopteris unita* Brgt.

It is still doubtful if the genus *Crematopteris* Schp., with a frond simply pinnate and leaflets vertically placed, ovate, oblong, very entire, without any trace of nerves, should be referred to the *Pecopterideæ* as it has been generally done. It is still more uncertain if our species *Crematopteris Pennsylvanica* Lsqx., belongs to this genus or is referable to it. The only specimen ever found of this fossil plant is figured Tab. 3, fig. 5, of the Penn. Report. It may be part of an undeveloped frond or even part of a root. This species like *Scolopendrites grossi-dentata* Lsqx., (same Rep., p. 868, tab. 8, fig. 7,) ought to be left as plants of undetermined affinity, till better specimens shall have been found.

Sphenopterideæ Brgt.

The fossil plants referable to this tribe are, even for the same species, extremely variable in their characters. This causes a great difficulty in their classification. Prof. Brongniart has remarked indeed that a division of the *Sphenopterideæ* would be possible, in combining characters drawn from the form of the pinnules and from the nervation; but he has not proposed any one himself. Prof. Göppert has divided the *Sphenopterideæ* in three genera only: *Sphenopteris*, *Hymenophillites*, and *Trichomanites*. With the exception of this last genus to which none of our species can be referred, this classification is admitted for our *Sphenopterideæ*.

The genus *Sphenopteris* Brgt. is still subdivided by Göppert in three sections, named here in an order contrary to that of the author.

1st. *Dicksonioides:* frond bi-tripinnate, pinnules suboblique, sessile, often united together at the base, entire or lobed or pinnately divided. Nerves pinnate, flexuous, distant, the inferior ones forking or dichotomous, the superior ones simple. This sec-

tion makes a link of union between the *Pecopterideæ* and the *Sphenopterideæ*, containing, as before said, some species referred by Brongniart to the genus *Pecopteris*. Of this section we have in our coal-measures: *Sphenopteris paupercula* Lsqx., (Geol. Rep. of Ill. ined. pl. 5, fig. 4 and 4*a*,) related to *Pecopteris Shoenleiniana* Brgt. *Sphenopteris* spec. nov. (ined.), distinguishable from *Pecopteris Murrayani* Brgt. only by the *slightly pointed and once-toothed* lobes of the pinnules that in the European species are roundish and entire. *Sphenopteris abbreviata* Lsqx., *S. plicata* Lsqx., a species established from a too small and incomplete specimen with nerves entirely obliterated and perhaps referable to *Pecopteris Pluckneti* Brgt.; *Sphenopteris intermedia* Lsqx., *Sp. Davalliana* Göpp, *Sp. Dubuissonis* Brgt., *Sp. Gravenhorstii* Brgt., and *Sp. flagellaris* Lsqx. I would even join to this division *Alethopteris serrula* Lsqx., a beautiful species that has some relation of form and nervation with this last one and that has no natural affinity with *Alethopteris*.

2d. *Cheilanthoides* Göpp. Frond bi-tripinnate with sometimes entire, mostly pinnately lobed pinnules. Nerves pinnate and secondary nerves mostly geminate in each lobe and forked near the top. Our American species of this section are: *Sphenopteris latifolia* Brgt., *Sp. acuta* Brgt., *Sp. obtusiloba* Brgt., *Sp. irregularis* Sternb., *Sp. polyphylla* Ll. and Hutt., *Sp. glandulosa* Lsqx., and *Sp. squamosa* Lsqx.*

3d. *Davalloides* Göpp. Frond bi-tripinnate, pinnules or lobes of the pinnules wedge-form; nerves oblique, ascending, single or double in each lobe. As referable to this section, we have: *Sphenopteris trilactylites* Brgt., *Sp. spinosa* Göpp., *Sp. distans* Sternb., *Sp. dilatata* Lsqx., *Sp. decipiens* Lsqx., and *Sp. rigida* Brgt.

If the American species do not throw any new light on the genus *Sphenopteris*, scantily represented in our coal-measures, it is I think different with those referable to the genus *Hymenophyllites* Göpp.

This genus is nearly related to existing species of *Hymenophyllum* and *Trichomanes*. According to Göppert, it has for characters: a frond bi-tripinnate, either irregularly cut-lobed or pinnatifid, with the divisions decurrent on a filiform rachis. Nerves pinnate or dichotomous, simple in each lobe or excurrent. I have formerly (page 69, vol. xxx, of this Journal) alluded to some species of disputed affinity, that were at first separated in a peculiar genus, *Pachyphyllum* Lsqx., (Penn. Geol. Rep. p. 863,) and afterward referred to a separate section of the genus *Hymenophyllites* Göpp., (Cat. of Fossil Plants,) for the following reasons:

1st. Living species referable to the genus *Hymenophyllum* have two different typical forms to which both the proposed sections

* The nervation of this species is unknown. The general form of its divisions is that of *Pecopteris Sillimani*.

of *Hymenophyllites* are evidently related. The species belonging to the first have a lanceolate, bi-tripinnate frond with forked pinnules. All its divisions are dichotomous, linear and decurrent upon a narrow, half round or flattened rachis. The nerves divide according to the divisions of the frond and the nervules simple in each lobe are excurrent. Of species referable to this section we have from our coal-measures: *Hymenophyllites Hildrethi* Lsqx., *H. flexicaulis* Lsqx., (Geol. Rep. of Ark., p. 309, pl. 1, fig. 1 and 1*a*,) *Hymenophyllites pinnatifidus* Lsqx., (Geol. Rept. of Ill. ined., pl. 2, fig. 2 and 2*a*,) *Hymenophyllites furcatus* Göpp., and *H. artemisiæfolius* Brgt. The other typical form of the genus *Hymenophyllum* to which another section of our fossil *Hymenophyllites* is related has for characters: a simple, cartilaginous frond, nearly round or oval-lanceolate in outline, irregularly pinnately cut-lobed in short obtuse divisions. The medial nerve at its base is the continuation of a short, naked pedicel, emerging from a creeping rhizome. The nerves are dichotomous, forking and thinning in ascending and the nervules simple and decurrent in each division. Indeed, although the general appearance of the species belonging to both these sections is far different, it results only from a greater or lesser expansion of the limb of the frond. In the first case, there is only a narrow strip of it extending on each side of the nerves and following them in their divisions, in the second, the *derma* is broader and sometimes fill the space between the nerves except near their extremities. It appears evident that all our species related to the second section of *Hymenophyllites* have the same characters as described above. All have a strong generally inflated basilar nerve, dichotomous or forking in ascending, with simple nerves, decurrent to the top of more or less irregular divisions; all also appear to have had a cartilaginous frond. Some authors assert that species like *Hymenophyllites giganteus* Lsqx., (*Schizopteris lactuca* Göpp.) cannot belong to the ferns. But our American specimens have apparently either a pinnate frond with large pinnæ attached on a common rachis, or a compound of simple fronds attached to one side of a creeping rhizome, and thus are fern-like. Our other American species are still more related to the ferns than the former.

With *Hymenophyllites giganteus* Lsqx., we have from our coal-measures: *Hymenophyllites laceratus* Lsqx., *H. hirsutus* Lsqx., *H. affinis* Lsqx., *H. fimbriatus* Lsqx., *H. adnascens* Ll. and H., and a new species from Rhode Island, related to the *Hymenophyllites giganteus*, but with broad obtuse lobes.

Another reason for abandoning the genus *Pachyphyllum* is, that some of the species now under examination have already been referred by European authors to five different genera, *Schizopteris*, *Aphlebia*, *Filicites*, *Fucoides*, and *Algacites*. The two first

only have been preserved for *Hymenophyllites giganteus*, but their characters are entirely at a variance with those of this and of the other species of this group. Brongniart characterizes his genus *Schizopteris* thus: Frond irregularly forking, sub-dichotomous or pinnately lobed; lobes fastigiate, elongated, enlarged-cuneiform at the top, truncate, without rachis and primary nerves; nervules very thin, parallel, equal, forking, &c. The genus *Aphlebia* Sternb., is from its character still less adapted for our plants, its characters being: frond lobate or flabellate, pinnatifid or pinnate, lobes or laciniæ plane, nerves and veins none; rhizome filiform, ascending. Moreover, both these genera characterized as they are, have no affinity with any other of the fossil plants and thus their place is uncertain.

(*To be continued.*)

ART. XXI.—*Abstract of a Meteorological Journal, kept at Marietta, Ohio:* lat. 39° 25′ N., and long. 4° 28′ W. from Washington City, for the year 1861; by S. P. HILDRETH, M.D.—[Thirty-fifth annual Report.]

MONTHS.	THERMOMETER.			Fair days.	Cloudy days.	RAIN	WINDS.	BAROMETER.		
	Mean.	Maximum.	Minimum.			Inches. Thous'ths.		Maximum.	Minimum.	Range.
January,	32°·33	51	10	12	19	2·704	W., N. & S.	29·75	28·84	·75
February,	38·20	69	2	12	16	2·316	S., S.W. & E.	29·75	28·85	·90
March,	43·00	75	15	12	19	2·278	S., S.W. & N.	29·78	28·95	·83
April,	52·70	82	30	14	14	6·372	N., N.W., S. & E.	29·60	28·95	·65
May,	56·39	86	28	15	16	5·619	N., N.E. & S.	29·65	28·65	1·00
June,	70·25	92	44	16	14	3·961	S., S.W. & N.	29·68	29·15	·43
July,	68·17	90	48	16	15	5·146	S., S.W. & N.	29·60	29 20	·40
August,	71·00	94	50	18	13	3·031	S., S.W. & E.	29·60	29·10	·50
September,	66·00	89	36	18	12	4·312	S., S. E., & N.	29·84	28·88	·92
October,	44·20	79	28	15	16	4·433	S., S.W. & E.	29·80	28·95	·85
November,	41·33	71	25	14	16	4·631	N., N.W. & W.	29·64	28·85	·79
December,	37·00	69	12	21	10	1·618	S., S.W. & N.	30·00	29·10	·90
Mean for the year,	51°·71			185	180	46·441				

The mean temperature for the year is 51°·71, being not far from the average of a series of years.

The amount of rain and melted snow is 46·441 inches and considerably above the mean for this locality.

Winter months.—The mean temperature for the winter is 33°·55. It was a very mild winter—the mercury being at no time at zero, though very near that point. The Ohio river was not closed, so as to prevent navigation, but contained at times considerable floating ice, lasting only a few days. There was but little snow.

Spring months.—The mean temperature of spring was 50°·69, which is nearly two degrees below the average, this season varying in different years from fifty to fifty-seven degrees.

Summer months.—The mean for summer was 69°·80, which is rather below the usual temperature for this season of the year, the mercury at no time rising above 92°.

Autumn months.—The temperature for autumn is 50°·51, which is two or three degrees below the average. In the year 1854, the mean of this season was 56°·50, a notable variation. The first snow fell on the 24th of the month of November, about half an inch, but melted away in a few days.

Remarks on the year 1861.—The year has not been marked by any great extremes of temperature—the coldest day being two degrees above zero, and the hottest, ninety-two degrees. There has been no suffering of the crops of grain and grass from drouth, but an abundant supply of rain has fallen, and at times when most needed. In the northerly and eastern portions of Ohio, an unusual quantity of rain has fallen, causing disastrous floods in the streams at unusual seasons of the year. In Columbiana county, on the 12th of August, there fell in six hours, seven inches of rain.* The water courses, unable to hold this quantity, overflowed their banks, sweeping the bottom lands of their crops, and many bridges from the Big Beaver creek and its branches. The latter part of September excessive rains fell on the headwaters and branches of the Alleghany, Monongahela and Kanawha rivers, causing destructive floods in all these streams, especially that of the Big Kanawha. The rain commenced on the 26th of September, in the afternoon, and by Sunday morning at one o'clock, the river at Charleston had risen fifty-eight feet. It began to rise on Friday evening, and in twelve hours rose forty-five feet, nearly four feet an hour; a proof of the excessive rains in the mountains at the head of the stream. The ravages on this river were greater than on any other, destroying the salt works and all the crops within its reach.

The borders of the Alleghany river not only suffered in the destruction of crops, but also in the loss of great quantities of pine boards and lumber of all kinds. The Ohio river, at Marietta, on the 29th and 30th of September, was covered with drift, embracing saw logs, boards, bridges and fences, with the dead bodies of many domestic animals. The banks were nearly full, but did not overflow the town. Crops of corn on the low bottoms of the Ohio and Scioto rivers were destroyed, to the amount of several hundred thousand bushels. The Muskingum river was not unusually high; and the crops suffered less than on many other streams. The Little Kanawha was higher than ever

* See this Jour., xxxii, 296.

known, and the region of "Rock Oil," suffered the loss of more than a thousand casks, besides the destruction of reservoirs, buildings, and engines. The effects of the September flood will long be remembered.

On the morning of the second day of May, a disastrous frost visited all the southern and middle portions of Ohio, ruining the apple and peach crop of 1861. The trees were in bloom on the 22d of April, and the fruit well set. A similar calamity visited Washington county, the third day of May, in 1803. The apples then were as large as ounce balls. In Indiana and Illinois, the apple crop was uninjured. The wheat was not hurt by frosts, but in places suffered from the ravages of an insect, eating the grain while yet in the milk. Indian corn, potatoes, oats and hay, produced largely. Grapes and the smaller fruits partly compensated the loss of apples, and were in great abundance. The forests were full of nuts and acorns, so that this may be called a fruitful year.

Floral calendar, ripening of fruit, &c.—March 4th, Robins appear; 19th, Blossoms of Magnolia conspicua nearly open, but injured by frosts; 27th, Martin birds seen; 28th, Daffodil in bloom; 29th, Hepatica triloba and yellow primrose.—April 1st, early Hyacinth; 4th, Peach in bloom on the hills; 7th, Peach in bloom in the bottoms; 8th, Forsythia viridis; 9th, Sanguinaria canadensis; 10th, Hyacinth; 12th, Primroses; 13th, Pear trees, Spiræa prunifolia, Scotch gooseberry; 15th, Scarlet Pyrus Japonica; 17th, Siberian crab; 18th, pink colored Japonica; 19th, Garden currant; 20th, white Narcissus; 21st, Red-bud tree, vernal Snow drop; 23d, yellow root; 25th, Apple tree in full bloom.—May 1st, Cornus Florida; 2d, Harebell; 6th, Haw tree, Pæonia montanus, garden pea in bloom; 10th, Tulips; 14th, Horse chestnut, Snowball; 18th, Wigelia rosea; 19th, yellow Harrison rose, Magnolia tripetala; 21st, yellow and white Moccasin flower; 25th, Lawton blackberry; 26th, Variegated Iris; 27th, Rose acacia; 28th, Seedling Peonies; 29th, white and purple China Peonies; 30th, common Locust tree.—June 4th, Syringa fragrans; 6th, blue Iris, Strawberry ripe; 9th, Syringa Philadelphica; 18th, Magnolia glauca; 23d, Prairie rose; 24th, red Raspberry ripe; 25th, Catalpa in bloom; 30th, Catawissa Raspberry ripe.—July 5th, Sweet Bough apple ripe; 17th American broom in bloom; 19th, Blackberry ripe.—August 5th, Catharine pear ripe; 12th, Watermelons; 13th, Peaches ripe; 23d, Burgundy pear ripe.—Sept. 4th, St. Michael's pear; 15th, Seckle pear ripe.

Marietta, Ohio, January 2d, 1862.

ART. XXII.—*On the Study of the Electric Spark by the aid of Photography;* by Prof. OGDEN N. ROOD, of Troy, N. Y.

PHOTOGRAPHIC images of the electric spark between the carbon electrodes of the voltaic pile were obtained on silver plates in November, 1840, by Prof. B. Silliman, Jr. and Dr. W. H. Goode, (see this Journal [1], xliii, 185). These observers remarked the greater actinic activity of the negative spark as compared with the light from the positive electrode, which I believe is the earliest recorded observation on this point. These authors also noticed a double concentric structure in the impression from the electric spark similar to that described in this paper.

Photographs of the stratification and luminous discharges in Geisler's tubes were obtained in the spring of 1860, by Prof. W. B. Rogers of Boston, operating with one of Ritchie's coils. These results were communicated to the British Association at their Oxford meeting in June, 1860, (Report, &c., Abstracts, p. 30.)

Similar photographs were obtained by Gunther and Dove, and presented by the latter to the Prussian Academy, on the 27th of May, 1861. A photographic camera was employed, and an exposure of from $3\frac{1}{3}$ to 6 minutes.* In the same number of Poggendorff's Journal, W. Feddersen, in a highly interesting article on the electric discharge from the Leyden jar, states, that by means of a concave mirror silvered according to Liebig's process, he obtained fine photographs of the electric spark, even when the mirror was in rapid rotation. Photographs of the spectra from the spark of Ruhmkorff's coil have also been obtained by Prof. W. A. Miller, (this Journal, vol. xxxii, No. 96, p. 408).

In all these cases the electric light was photographed from a position at right angles to its motion, a side view being obtained: my object in the present article, is to describe a very simple and easy method of obtaining remarkably fine photographs of the electric spark, from a point of view parallel to the direction of its motion, the pictures being as it were transverse sections of the spark and of the electric brush in all its variety. The very short duration of the electrical discharge, renders its study by ordinary means difficult and uncertain: while photography, by revealing a mass of new details otherwise invisible, and furnishing a permanent record, which can be studied at leisure, offers advantages that cannot be too highly estimated.

Method employed.—M. E. Becquerel showed several years ago, that paper coated with the bromid of silver is sensitive to the light of the electric spark; the discharge of a battery of four

* Pogg. Annalen, vol. cxiii, No. vii.

Leyden jars in its immediate neighborhood causing a slight darkening. When a single spark was allowed to strike the paper no effect was produced.*

In experiments on instantaneous photography, with the wet collodion process, I was often encountered by the well known fact, that while those portions of the sensitive surface which had been acted on by a very bright light darkened strongly under the developing solution, adjacent parts, where the action of the light had been somewhat feebler, remained quite transparent and free from a deposit of silver. This rendered it probable to me, that if the electric spark were made to strike directly on the sensitive surface, only those portions would be affected which were in immediate contact with the luminous atmosphere. Actual experiment confirmed this idea to a most surprising degree: when a single spark was allowed to fall on the sensitive surface, under the action of the developing solution a fine, intense, and sharply defined image, full of delicate details, was produced. The sharpness and perfection of these images was such that they bore examination by the microscope under a power of 40 diameters, while there was not the least difficulty in enlarging them by means of photography as high as 20 diameters. The enlarged negatives then furnished good prints on paper. Sometimes the small original images were accompanied by an irregular partial halo caused by the diffused light of the spark, but this for the most part was so faint as in no way to interfere with the distinctness of their outline.

The question naturally arises whether these delicate and beautiful images are produced by the action of the *light* on the sensitive plate, or are owing to a decomposition of the silver salt by electrical agency, in other words whether these pictures are photographs or electrographs. That they are due to the action of light the following experiments will render probable.

(1.) Sparks were allowed to fall on sensitive plates and their form was observed by the aid of a lens of one inch focal length; on developing the latent images they corresponded in shape with those observed.

(2.) A glass plate was coated with plain collodion, free from iodid or bromid, and allowed to remain five minutes in the bath of nitrate of silver: it was then removed, and single sparks were allowed to fall on different portions of the wet collodion surface: under the action of the developer the well known spark images appeared.

A simple clean glass plate without any coating at all was placed in the nitrate bath for a few seconds; on its removal and while still quite wet, sparks were discharged on different portions of

* Pogg. Annl., vol. liv, p. 54.

its surface; when the sulphate of iron developing solution was poured over it as usual, clear, sharp images of the spark were obtained!

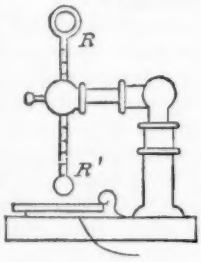
As plain collodion free from iodid and bromid as well as simple glass plates moistened merely by the nitrate bath have not been considered by photographers as sensitive to light, these unexpected results rendered it probable that the electrical discharge produced a decomposition of the nitrate of silver. I was, however, enabled to prove that these surfaces really are sensitive to *light*, in the following manner: A plate coated with collodion, free from iodid or bromid, but saturated with a solution of nitrate of silver from the bath, was placed in a camera which was directed towards a window with a bright sky beyond. The lens used was the "portrait combination," its focal length being six inches, with an aperture of $1\frac{1}{2}$ inches: the exposure lasted ten minutes, the full aperture being used. Under the sulphate of iron solution, a distinct image of the window, of no great intensity, was obtained. Next, sunlight was concentrated by a "bull's-eye" condenser on a little stand, which to avoid too great heat was arranged so that its surface was about half way between the lens and its focus, the bright spot on the stand covering an oval space $\frac{3}{4}$ of an inch in diameter and 2 inches long. A plate merely moistened by immersion in the nitrate bath, was placed on the stand for ten seconds, and then developed by the sulphate of iron solution, which brought out an intense image of the oval spot.

(3.) The image of the positive spark falling on a plate merely wet with nitrate of silver has a peculiar and definite form: if this form is really traced by *light*, we should expect that the light would be able to act on another sensitive plate placed directly under and in contact with the first. This was found to be the case: a glass plate coated with sensitive collodion, on its removal from the nitrate bath, was covered with a piece of the very thin glass used for microscopic purposes, the latter having previously been moistened by a solution of nitrate of silver; sparks were then discharged on the covering plate of thin glass. When the latter was removed and the collodion surface developed as usual, images of the spark were obtained. The definition was much impaired, and the intensity lessened. When the thin glass was blackened so as not to transmit light, and the experiment repeated, no images were produced, not even by allowing a large number of sparks to strike the same spot.

Apparatus for the production of the photographs.—For the generation of the electricity a small cylinder machine was used: the diameter of the cylinder was seven inches, its length ten inches; the prime conductor exposed a surface of 200 square inches.

The apparatus for throwing the spark on the sensitive plate is seen in the diagram: a brass rod R R', terminated by a freshly polished brass ball six-tenths of an inch in diameter, is supported over the centre of the sensitive plate and insulated in the manner seen in the wood cut (fig. 1): the rod is graduated and held in position by a binding screw. The sensitive plate is supported on a silver disc, which is in metallic connexion with the rubber of the machine; a weak spring of platinum foil rests on the collodion film and connects it with the silver disc; R is connected with the prime conductor.

1.



The manipulation was as follows: a glass plate three inches square was carefully cleaned, coated with collodion, and sensitized in a bath of nitrate of silver of 40 grains to the ounce of water: the plate on being taken from the bath was held in an upright position, so that it could *drain* for one or two minutes; it was then placed on the stand, and the machine very slowly turned, until an apparently single discharge had been effected, when the plate was removed about three-tenths of an inch and the operation repeated until twenty sparks had fallen upon it. The plate was then developed and fixed as usual; after each experiment the brass ball was wiped to remove dust, &c.

The pictures produced in this way are apt to be too intense, whereby the interior details are often obscured. Some care must therefore be taken in the selection of a collodion; that which is suitable for "ambrotypes" is to be preferred: the following formula answered well in my hands.

Plain collodion, - - - - -	8 oz.
Iodid of potassium, - - - -	40 grains.
Bromid of ammonium, - - - -	20 do.

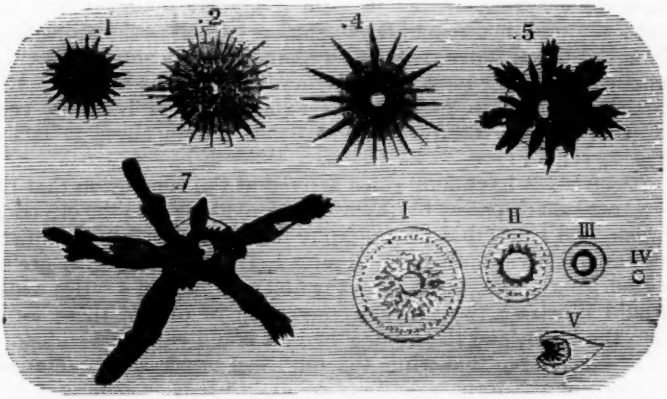
This collodion should be used while still new, as it then is sensitive and not too intense in its action.

Form of the positive spark when drawn from the prime conductor by a short thick metallic rod.

The positive electrical spark under these circumstances consists of a combination of two figures, viz.: a star and one or more rings. The relation which they hold to each other is modified by the distance the spark travels in the air, that is by the tension of the electricity: the two figures are usually arranged with a considerable degree of symmetry. The very marked difference in these two components, and the fact that the annular form is, as I shall show, characteristic of the electrical brush,

seems to indicate that each simple spark consists of two or more successive discharges of different intensity. The wood cuts showing the forms of the spark were executed from photographs enlarged 9 diameters; in them the bright portions of the spark are of course represented by dark shading, &c.

2.



Distance of the brass ball from the sensitive plate $\frac{1}{10}$ inch. The most general form is that seen in diagram 2, at .1: the starlike figure is very distinct, one of the rings is included within its area and faintly indicated by a deeper shade: the other ring is sometimes seen circumscribing it.

$\frac{2}{10}$ .2. The rays are larger and the external ring is plainly visible.

$\frac{3}{10}$ and $\frac{4}{10}$. .4 The rays increase in size and the ring is well developed.

$\frac{5}{10}$. Like the above except that the rays begin to grow irregular.

$\frac{6}{10}$. Rays quite irregular, both rings distinctly visible.

$\frac{7}{10}$, $\frac{8}{10}$, $\frac{9}{10}$, 1, $1\frac{1}{10}$, $1\frac{2}{10}$. The star loses its regularity and the rings are no longer symmetrically disposed.

$1\frac{3}{10}$. No spark passes over, it is replaced by the electrical brush, or rather by discharges intermediate between the brush and the true spark, fig. 2, I.

These produce a strong impression on the plate and yield intense sharp figures consisting of three parts: an external sharply defined circle, within a series of dots arranged in a circle, and finally innermost of all a broad ring which may pass by delicate gradations into a star. This would indicate that the partial spark consists, under these circumstances of at least three successive discharges of electricity of different tension. The circles on the plate seem to have exactly the same diameter they possess in the air: this is strongly suggested by the following experiment: if the plate is held obliquely the partial sparks generally pass near its surfaces for some little distance before actually coming

in contact with it, and their path is marked by comet-like tails (see fig. 3). The diameter of these tails is the same with that of the circles. This is also true of the brush.

3.

Electrical brush.—When owing to distance or the use of a pointed wire these partial sparks become reduced in intensity we have the electrical brush: its form is slightly removed from the last; the middle circle of dots vanishes as well as the projections from the broad inner ring, and we have two concentric rings, the smaller one being most strongly marked. If the brush be still farther reduced in intensity the external circle becomes very faint and finally disappears, and but a single circle is left.—Fig. 2, III, IV.

Electricians have long since arrived at the conclusion that the electrical spark passes by insensible gradations into the electrical brush, and I find that photography furnishes a beautiful confirmation of this view: thus the figures I, II, III, IV, Fig. 2, are selected from photographs form the first members of a series which would illustrate the gradual conversion of one of these forms into the other, and the other members could easily be added.

We have seen that while the electrical brush is characterized by the annular form, electricity of higher tension generates star-like figures, the rays being larger in proportion to the tension up to a certain point; now the constant occurrence of a combination of these two forms, in the photographs of *bright sparks*, points out, I think, clearly, that these sparks consist also of more than one discharge; moreover, the ring where it cuts the rays of the star can often be traced under them, as though superposition had taken place. Again, when the bright spark travels some distance the ring is generally not symmetrically placed, as though the discharge producing it had followed a slightly different path. Indications are constantly observed, which lead to the idea that even the star itself, is produced by the overlaping of two stars, having rays of different size and different intensity.

The wet collodion film offers of course a certain amount of resistance to the passage of electricity over its surface, and thus furnishes us with the different indications above decribed.

Finally, as the researches of Riess, Kirchhoff, Helmholtz and Feddersen, have shown that the electrical discharge is oscillatory and wave-like, I am the more inclined to regard these photographic figures as produced by a series of consecutive discharges of different intensity.

Before passing on to the next point of interest, I will allude to a curious modification which the positive partial spark undergoes if the machine be turned rapidly, so that a large number of them fall quickly on the same spot: see V, fig. 2. Many of the partial sparks are arranged radially around the point under the brass ball, the pointed portion being turned outward.

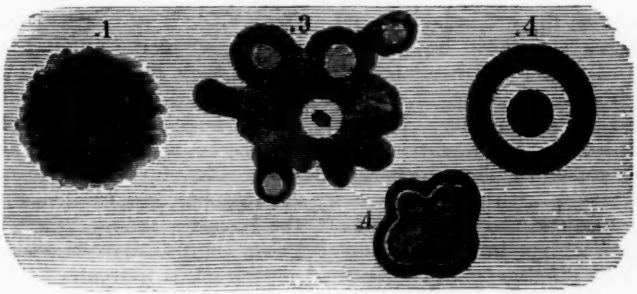
Form of the negative spark when drawn from the prime conductor by a short metallic rod.

The production of Lichtenberg's figures has been considered as indicative of a real difference between positive and negative electricity. Riess, who has examined this subject with great care, found that in addition to the marked difference in the two forms, the diameter of the positive figure is to that of the negative as 2·77 is to 1. The same physicist has lately made an elaborate examination of Priestly's rings, which are formed when a large number of sparks strike on polished plates of metal, and arrived at the conclusion that the set of rings generated by negative electricity is quite different from that produced by positive.* It consequently becomes very interesting to ascertain whether such difference also prevails between the photographs of the two sparks.

The apparatus was arranged as before and sparks of negative electricity fell on the sensitive surface.

The form of the negative spark was found to be quite different from that of the positive: it was destitute of rays, circular in shape and often made up of a number of minute circles placed without symmetry. For short distances it was much larger than the positive spark and never nearly so well defined.

4.



Distance of $\frac{1}{10}$ of inch. Round discs showing by their shading indications of internal structure. Fig. 4 .1.

$\frac{2}{10}$. Similar to above.

$\frac{3}{10}$. Discs broken up into a number of small circles. See .3.

$\frac{4}{10}$. See diagram .4.

$\frac{5}{10}$. The same as above; sometimes the form at A is produced.

$\frac{6}{10}$. No spark passes over: the partial discharges produce no figures, but merely a general blackening of the plate under the developer.

* Pogg. Annalen, vol. cxiv, No. 10, p. 193.

If the sensitive plate be placed on the prime conductor charged with positive electricity, and sparks be drawn from the surface of the plate, the negative figure is produced; if the plate rest on a conductor charged with negative electricity and sparks be drawn from it the positive form is obtained; and finally, if the plate be coated on both sides with collodion and insulated with a brass ball before and behind it, one of them being also insulated, while the other is in communication with the ground—if now a spark of either kind of electricity be allowed to pass from the insulated ball to the plate and from the plate to the second ball, we obtain as would be expected, on the opposite sides of the plate, the negative and positive images by development.

It is well known that when the knob of a jar, charged with positive electricity, is touched to a thin plate of pitch, a yellow star-like figure is produced by sprinkling the plate with a mixture of powdered sulphur and red lead; while if negative electricity is used a rounded red figure is formed. These figures bear the name of their discoverer, Lichtenberg. The method employed by Riess is much better calculated to give accurate results than the common one just mentioned: a small square plate of copper is coated thinly with black pitch on one side: the point of an insulated metallic rod touches the centre of the pitch surface, while the other side of the plate is in metallic connection with the ground. If now a spark from a jar charged with positive electricity be allowed to pass over to the pointed rod, and the latter still insulated be removed, then by sprinkling the pitch with a mixture of sulphur and red lead the star is generated in great purity: very perfect red negative figures are of course formed in a corresponding manner.

In repeating these experiments after the manner of Riess, I was struck with the resemblance existing between the red negative disc and the photographs of the negative spark. There is also much general resemblance between the positive yellow star and the photographs of the positive spark: this is greatly heightened if the yellow positive figures are produced in the following ways: the pitch plate is held at such a distance from the ball of the prime conductor that no spark can pass over, the machine is turned and the brush is allowed to strike it for an instant: on powdering the plate a multitude of small yellow stars very much like the photographs appear. They are often surrounded by small red circles, such portions having become negative by induction.

The results obtained with Leyden jars, and in a partial vacuum, as well as by the use of metallic plates, I propose to detail on a future occasion.

Troy, Jan. 6th, 1862.

ART. XXIII.—*On the Production of the Methyl Bases, and on the Preparation of Nitrate of Methyl;* by M. CAREY LEA, Philadelphia.

(1.) *On the Production of the Methyl Bases.*

HAVING found in the nitrate of ethyl so convenient a source for the production of the ethyl bases, I was naturally led to endeavor to employ it for the preparation of the corresponding substances in the methyl series, and the result proved eminently satisfactory.

When nitrate of methyl was placed in a sealed tube and immersed in water at 120° F. for an hour or two, a crystallization already took place. In a subsequent experiment it was found that complete decomposition was effected in about three hours at a temperature of 180° to 190° F. But with methylic nitrate we may dispense with sealed tubes altogether, in which respect the methylic bases are more easily obtained than the ethylic.

Bottles provided with well ground stoppers are filled one-third full with a mixture of nitrate of methyl and of the strongest liquid ammonia, in the proportion of 14 parts by volume of nitrate of methyl to 15 of liquid ammonia. The liquid ammonia which I used was a thoroughly saturated solution of the gas. In from five to seven days decomposition is complete and the nitrate of methyl has disappeared. This time may be somewhat reduced by frequent agitation, and by placing the bottles on the second day at a temperature of 90° F., and on the third at 100°. In this way three days complete the process. It is not even necessary to secure the stoppers, if the operation is performed at ordinary temperatures.

The solution then contains ammonia, methylamine, and at least one more substituted ammonia. The separation of the methyl bases is a matter of extraordinary difficulty. I am now engaged in studying it and hope to publish my results at a future time.

(2.) *On the Production of Nitrate of Methyl.*

For the production of nitrate of methyl but one process appears to have been proposed, and that is to be found in all our text-books, English, German and French. Two parts of powdered nitre are to be distilled in a capacious flask with a recently prepared mixture of 5 parts wood spirit and 10 oil of vitriol. Judging from the reactions of ethylic alcohol, it did not appear to me probable that such a proceeding could succeed. It was tried, however, and with the following results.

The substances were placed in a flask capable of containing twenty times their united volume, which was connected with a

Liebig's condenser by a wide delivery tube. For a few minutes no action was perceptible, but it soon set in, with rapidly increasing violence. Torrents of gaseous products with deep red fumes of oxyds of nitrogen, were evolved, and presently the apparatus blew up with a loud explosion, and had not due precautions been taken with a view to a possible unpleasant conclusion, personal inconvenience might have resulted, for the 3-litre flask was shattered into very small pieces, which were thrown to a considerable distance. The quantities operated upon were small, 50 grammes of methylic alcohol and proportionate quantities of the other substances. No heat was applied.

It is scarcely probable that the gases were evolved in such quantities as to have caused the explosion. It seems more likely that the heat generated by the reaction was sufficient to raise the temperature of the interior of the flask to 150° C., at or below which point, according to Dumas, the vapor of methylic nitrate explodes.

I have had no difficulty, however, in preparing this ether by a different process. By dissolving a considerable quantity of urea or nitrate of urea in methylic alcohol, it supports the action of nitric acid with the utmost facility. The following are the proportions which I have employed.

Into a retort of the capacity of a litre, 200 c. c. of purified wood spirit are placed and about 40 grammes of nitrate of urea are added and heat applied. When solution has nearly taken place, 150 c. c. of nitric acid free from the lower oxyds of nitrogen,* sp. gr. 1·31, are added, and the mixture is distilled to one-third. 170 c. c. of wood spirit and 130 of nitric acid are then added and distilled to the same point. Finally 150 c. c. wood spirit and 110 nitric acid with 10 grammes of nitrate of urea are added, and distilled to the same point as before. It is useless to carry the distillation further than the point here specified, not that it is accompanied by any inconvenience, but because nitrate of methyl ceases to be evolved. The temperature rises very high at the close of the distillation.

The operation may be carried on rapidly. We are recommended in the text-books to carry off the vapors very carefully in preparing nitrate of methyl, on account of the production of cyanhydric acid as a by-product. In chemical laboratories there is doubtless generally rather too little precaution taken than too much against noxious vapors, but in the present case, I have carefully examined the distillate, both in the old process, which failed, and in that which I here propose, and I could find no

* Freedom from the lower oxyds is an essential condition of success. That nitric acid is colorless is not in itself a sufficient indication of purity in this respect. An acid which causes the least darkening to a solution of ferrous sulphate is wholly unfit for use in the preparation of either methylic or ethylic nitrate.

trace of cyanhydric acid either by the iron or the silver tests, or by conversion into sulphocyanid. Both the ether itself and the watery part of the distillate were tested. As however it is impossible without special analysis to know what impurities may be present in so variable a substance as commercial wood spirit, it is difficult to foresee what substances may be generated in its decomposition, but I think I am justified in concluding that cyanhydric acid is not generated by the action of nitric acid upon methylic alcohol; at least not in the presence of urea.

Treated as above described, 420 grammes of wood spirit yielded a distillate from which by agitation with solution of salt, there separated the very large quantity of 300 grammes crude nitrate of methyl. This may be subsequently agitated with a little weak solution of carbonated alkali.

The wood spirit before use should be distilled with one-third of its bulk of very strong (almost saturated) solution of caustic soda, to decompose any acetate of methyl which may be present. This operation must be performed over the water bath.

Philadelphia, Nov., 1861.

Art. XXIV.—*Colored Derivatives of Naphthaline;* by M. Carey Lea, Philadelphia.

In the course of a variety of experiments on the effects of reducing agents upon dinitronaphthaline undertaken some time since, I made some observations which appeared to me to be of interest. But not having access to the publications of several chemists engaged in the same direction, I could not ascertain how far they were new.

I now find by the able résumé of M. Emile Kopp in the *Rep. de Chemie Appliquée*, that my results have been in a considerable degree anticipated. One reaction, however, I do not see mentioned, and as it is rather curious, I give it here.

If a solution of protochlorid of tin in strong solution of caustic soda be brought to the boiling point, and an extremely minute quantity of dinitronaphthaline be added, and the whole be boiled a few moments, a clear solution is obtained, having a blackish blue color with a tinge of green. If this be poured into a large quantity of water, the dingy blue changes to a magnificent purple, of great depth and richness. If pieces of woolen or silk be dipped for an instant into the blue liquid, they come out bluish black—if they are then washed with plenty of water they exhibit a similar change, and assume a full, rich purple shade. This color is brightened by soap and hot water, and

resists dilute acids. In diffuse light it stands tolerably, but prolonged exposure to sunlight causes it to fade.*

The production of this color does not take place unless the proportion of dinitronaphthaline is extremely small in comparison with the quantity of reducing solution, one part to one or two hundred; if more is employed, the liquid assumes either a green, an olive, or a brown color, according to the quantity of the naphthaline compound. If the proportion has been too large, the liquid, when poured into water, instead of a rich purple, gives a dull purple, a lilac, a lilac brown, a green or an olive shade, according to the degree of excess in the dinitronaphthaline. A somewhat similar change in the dyeing effect is produced. It requires care and repeated experiment to obtain the exact proportions necessary for the production of the brilliant color.

I also obtained the solid purple coloring matter described by the French chemists as resulting from the action of stannous chlorid on dinitronaphthaline. The difference appears to be that the substance which I here describe seems to be only capable of existing in a caustic alkaline solution, for if the blue liquid be neutralized by even a weak acid its color is destroyed. Also that when enough dinitronaphthaline is employed to produce the *solid* coloring matter, the liquid portion, although even then of a green color, does not exhibit the characteristic change on dilution, but colors water of a dingy green. I do not mean to affirm that these products will necessarily prove to be positively and essentially distinct, but according to my experience, the production of the solid coloring matter is never accompanied by that of the liquid which exhibits this peculiar change of color, and which has not been, I believe, before described.

The blue solution left to itself decomposes in a few hours, becoming brown and muddy. The coloring power which it exhibits when fresh, is very remarkable. The solution obtained with a few milligrammes of dinitronaphthaline, suffices to impart a rich purple color to several litres of water.

Philadelphia, Dec. 21, 1861.

* The specimens of silk dyed with the purple here described by Mr. Lea, which he has kindly sent us, possess a delicate shade of lilac-purple.—Eds.

ART. XXV.—*Physiographical Sketch of that portion of the Rocky Mountain range, at the head waters of South Clear Creek, and east of Middle Park: with an enumeration of the plants collected in this district, in the summer months of* 1861; by C. C. PARRY, M.D.

WITH the exception of a few isolated peaks and elevated ridges in connection with the Appalachian mountain range, in no instance reaching an elevation of 7000 feet above the sea level, the truly alpine vegetation of the North American continent is confined to the remote region of the Rocky mountains. Here alone, within temperate latitudes, do we meet with mountain ranges where the summer sun is reflected from snowy wastes, and in which occur peaks attaining an elevation of over 12,000 feet.

Our previous knowledge of the general external features and peculiar vegetation of this alpine district, has been derived from the researches of various explorers, who have traveled hastily over this heretofore inhospitable region, noting the most prominent features of scenery along the ordinary routes of travel, determining the latitude and longitude of various fixed points, mapping out the direction of water-courses, sketching in the more prominent mountain ranges, and rarely, (as in the case of James, Douglas, Drummond, Nuttall, and Fremont,) making collections of its plants. From all these different sources of information, extending through the present century, we have derived a considerable though still imperfect knowledge of the peculiar natural features of our American Switzerland.

Within the past few years, however, the discovery of gold deposits in this portion of the mountain range has attracted thither an adventurous and enterprising population, settling with wonderful celerity its picturesque valleys and introducing into its wild recesses many of the arts and comforts of civilized life. These various social movements have afforded facilities for the prosecution of researches in natural history which were not enjoyed by the early pioneer explorers of this region.

In order to improve this opportunity, the writer was induced to make a journey to this region during the past season, (1861,) with the especial object of studying its alpine vegetation and making collections of its native plants. With this view a station was selected near the foot of the dividing ridge, at the head waters of South Clear Creek. From this point an extensive scope of alpine exposure was brought within the range of an ordinary day's journey. Here, among the pine-wooded slopes on both sides of the Snowy Range, coursing along its alpine brooks, clambering over its precipitous rocks, floundering through

snow-drifts, and mounting to its irregular crests and high alpine peaks, was spent most of the summer months of 1861. The scientific results of the observations here made, are presented in the following brief sketch and the accompanying list of plants.

The first impression made upon the traveller in approaching the mountain barrier from the broad undulating slope of the Great Plains, is the irregularity of outline and apparent want of system in the grouping and arrangement of the different ridges which compose the general mass of the mountain range. Some of the higher peaks rear their snowy summits at considerable distances from the dividing crest, and are met with at irregular points along the eastern slope. Numerous cross ridges interrupt the general parallelism of the principal ranges, and the actual "divide" is mostly obscured from view by elevated projecting spurs. The streams with their impetuous currents foaming along their rocky channels descend in a zigzag course, making their passage through intervening ridges by deep precipitous chasms. On reaching the more elevated mountain district, the valleys become more open, and frequently spread out into oval-shaped basins, to which the name of *bars* has been applied by the miners. Towards the head waters of the various streams, these basin-shaped portions of the principal valleys, beset with scattering groves of pine, encircled by steep ridges, generally clothed with heavy growths of spruce or exhibiting occasionally smooth grassy slopes, are known as *parks*. These are the miniature representatives of those larger open stretches of country which occur at the head waters of the Platte and Grand rivers, forming North, South, and Middle Parks.

In approaching the dividing ridge, by following up any of the principal streams by which the mountain range is penetrated, the open parks give place to narrow valleys, generally heavily timbered with pine and spruce. The water-courses force their way through narrow rocky *cañons*, or, obstructed by beaver dams, spread out into marshes occupied by a tangled growth of willow and alder bushes.

The smaller tributaries which collect the waters that trickle from alpine snows ebb and flow with the diurnal changes of temperature, increasing in volume as the sun ascends to relax the icy bonds of a protracted winter, and again contracting as the clear night once more asserts the reign of perpetual frost. These alpine brooks constitute one of the most attractive features of Rocky mountain scenery, and along their borders grow some of the finest plants of this region. Their course is that of a continuous *torrent*, presenting in their rapid descent a perpetual sheet of foam, rivalling in whiteness the snows in which they have their sources. Their waters of crystal purity and delicious coolness glisten in the deep shade of overhanging pines, and

moisten with their spray such choice plants as *Mertensia Sibirica*, *Cardamine cordifolia*, *Saxifraga æstivalis*, and a most elegant and conspicuous *Primula* (311) near *P. nivalis*.

In mounting up the steep ridges which border their course, to reach their alpine sources, the view of the surrounding country is entirely shut in by the heavy growth of pines, including on the higher ridges and abrupt slopes, *Pinus contorta* with its slender tapering trunk and stiff scanty foliage; while on more level spots, or occupying depressed basins forming sub-alpine marshes, *Abies alba* and *Abies balsamea* shoot up their tapering spires. The usual undergrowth in these pine woods is composed of *Vaccinium Myrtillus*, *Shepherdia argentea*, *Berberis Aquifolium*, *Pachystima Myrsinites*, &c.

In moist springy places and along the borders of marshes we find *Gaultheria Myrsinites*, *Pedicularis surrecta*, *Senecio triangularis*, *Mitella pentandra*, *Habenaria dilatata*, *Pyrola rotundifolia*, var. *uligmosa*, &c. As a rarity, in scattered localities, we here meet with the charming *Calypso borealis*.

On approaching the limits of arborescent growth, indicated at first by a stunted appearance of the common varieties of pine, as well as the more frequent occurrence of the alpine species, *Pinus flexilis*, we at length come somewhat abruptly upon open stretches, characterized by their peculiar vegetation and general aspect as truly alpine. Some few trees straggle for a variable distance up the abrupt rocky slopes, but in these situations they plainly exhibit the severity of the exposure by deformed and blasted trunks, often nearly prostrate, and showing by a uniform bending of their upper branches the direction of prevailing fierce winds, and the weight of wintry snows. These arctic forms are confined almost exclusively to a single species of pine, heretofore undescribed, (*Pinus aristata*, Engelm.) belonging to the same group as *Pinus flexilis*, James.

Beyond this there is a succession of alpine exposures, characterized by extensive patches of snow scattered irregularly over the mountain slopes, generally indicating the accumulation of drifts; being most abundant and persistent in recesses near the higher elevations. At other points a rough *talus* of rocks is spread over the surface, the separate blocks being of every conceivable shape, and loosely aggregated, forming numerous fissures. In these burrowing recesses the Siberian squirrel finds a congenial abode, and salutes the traveller with his reiterated bark, often the only animate sound to break the solitude of these alpine deserts. Through these loose masses quarried out by nature's hand, we often hear beneath our feet the gurgling of invisible streams, connecting by these subterranean channels elevated snow-banks with lower alpine brooks. Among these

rock crevices we meet with many of the rare and attractive plants of this district, including *Aquilegia brevistyla*, *Viola biflora*, a variety of *Ribes lacustre*, *Senecio Fremontii*, *Oxyria reniformis*, *Polygonum Bistorta*, &c.

Other portions of these mountain slopes are covered with a sward of alpine grasses, mingled with *Carices* and mountain clovers, all characterized by their peculiar tough, matted, and penetrating roots. In connection with these, almost every square yard presents a botanical feast of the most attractive and varied features. Neat little tufted plants of the most cerulean blue, including *Polemonium pulcherrimum*, *Mertensia alpina*, *Myostis nana*, Torr., (*Eritrichium aretioides?*) spot the surface. In scattered localities the bright yellow disk of *Actinella grandiflora* is conspicuous, while the varieties of alpine *Phlox*, *Primula angustifolia*, *Trifolium Parryii*, &c., supply almost every tint to complete a floral rainbow. Here also by a close inspection we discover such tiny plants as *Thalictrum alpinum*, *Gentiana prostrata*, and others almost hidden in the confused mass of matted foliage. In moist depressed places, and along the spongy margins of alpine lakes, we meet constantly with an alpine *Salix*, *Caltha leptosepala*, and a white *Trollius* near *Americanus*.

Toward the summit of the dividing ridge we find plants whose names plainly indicate the frigid climate to which they belong. Here grows the elegant flowered *Claytonia* which I have called *megarhiza*, sending its deep tap-roots into the crevices of rocks whose projecting angles shelter its succulent foliage from the rude blasts that sweep over these bald exposures. Affecting similar situations we meet with an alpine *Synthyris*, (255,) with its glossy foliage and neat spike of pale blue flowers.

On the summit of the crest, which here presents a flattened irregular surface, composed of weather-worn rocks imbedded in the coarse *debris* of its disintegrating granitic masses, we find *Trifolium nanum*, *Stenotus pygmæus*, *Papaver nudicaule*, *Saxifraga serpyllifolia*, *Gentiana frigida*, and others, all indicative of a rigorous climate, whose brief summer is thus elegantly adorned by these arctic forms of vegetation. Among the rarities of this district we may notice the newly discovered [or re-discovered] *Chionophila*, (256,) *Pedicularis Sudetica*, and several others well known in the Old World, but now for the first time added to the North American flora.

Such is a general and very imperfect sketch of the prominent features of the vegetation belonging to this elevated district, taking for a sample the alpine ridge at the head waters of *Mad Creek*, to which from my frequent visits I involuntarily applied the name of *Mount Flora*.

In my solitary wanderings over these rugged rocks and through these alpine meadows, resting at noon-day in some sunny nook,

overlooking wastes of snow and crystal lakes girdled with midsummer ice, I naturally associated some of the more prominent mountain peaks with distant and valued friends. To two twin peaks always conspicuous whenever a sufficient elevation was attained, I applied the names of *Torrey* and *Gray;* to an associated peak, a little less elevated but in other respects quite as remarkable in its peculiar situation and alpine features, I applied the name of *Mount Engelmann.* Thus following the example of the early and intrepid botanical explorer, Douglas, I have endeavored to commemorate the joint scientific services of our *triad* of North American botanists by giving their honored names to three snow-capped peaks in the Rocky mountains. With such innocent scientific pleasantry I felt at liberty to amuse the solitary hours of my mountain excursions, often wearied, but always enjoying with the keenest zest the magnificent scenery and rich botanical treasures that lay scattered along my varied path.

No description indeed can do justice to the grand features of scenery brought to view from the elevated points and commanding crests of this broad mountain range. While to the east the comparatively level plain stretches out like a boundless sea, in every other direction rise elevated peaks and snow-girt ridges, hemming in deeply sheltered valleys. An obscure parallelism of the principal ridges is here for the first time noticeable, more evidently marked however by the occurrence of culminating points forming broken lines extending northwest and southeast than by any continuity of the principal ridges. The *watershed* itself is a very irregular line, difficult to trace with the eye even from the most elevated points. This is owing to a very marked peculiarity of the range which exhibits the higher culminating points disposed quite constantly on the eastern slope of the divide, with which they are generally connected by depressed spurs. It is from these offsetting peaks that the most comprehensive views are obtained, and the general topography of the range can be best studied.

It may be noticed also that the most feasible *passes*, over the Snowy Range, are met with where the dividing ridge is inclined to an east and west course. In such situations the streams flowing thence north and south, respectively have their sources in the most depressed portions of the range, usually only a short distance apart.

In such a position, near the head waters of South Clear Creek is found the depression known as *Berthoud's Pass*, discovered by an Engineer of that name, while engaged in making a reconnoisance, for the location of a direct road from Denver to Salt Lake. In this pass the elevation at the highest point does not reach above the limits of arborescent growth, the dividing waters on either side heading but a few feet apart, in a pine grove.

Farther observation will be required, to show how far the accumulated snows of winter may offer obstructions to a through route, accessible at all seasons. The practical difficulties interposed by the steep ascent of the main abrupt slope can no doubt be readily overcome, by the construction of embankments and zigzags. When the principal height is once gained, farther progress is easy in either direction, by the usual appliances of road construction, for which the proper materials of stone and lumber are abundant, and of excellent quality.

The westward view takes in that irregular scope of country, including Middle Park, with its broad open spaces, encircled by broken ranges of mountains.

These mountains send down into the plain below, numerous spurs, heavily timbered with a magnificent growth of spruce, (*Abies alba*). Between these ridges, deeply sheltered valleys collect the tributary streams, forming the head waters of Grand River. The projecting mountain peaks on this side do not attain the height of those met with on the eastern slope, but the general surface is more elevated; the lowest depressions, occurring in the basin of *Middle Park*, being considerably higher than corresponding points on the great plains to the eastward. Hence the streams are less rapid, and the vegetation indicates a colder and more humid climate.

Here during the rainy season, in the months of July, and August, the different surface exposures give rise to variable atmospheric currents, which, meeting at various points, occasion a rapid development of clouds and aqueous precipitation, such as characterizes the sudden showers in this peculiar district. Here in fact may be studied to the best advantage, (though not always under agreeable circumstances), the formation of clouds, in their endless variety of shape, density, and progressive development. These at times may be seen gradually accumulating about the summits of snow covered peaks, thence spreading over the horizon and extending to the zenith, causing a regular steady rain; while at other times a sudden gust calls attention to a rapidly forming angry cloud, which sweeps over the surface in a well defined path, scattering rain, hail, or snow in its wake.

The regular afternoon showers which occur on the eastern slope are readily explained by referring them to the junction of heated air, charged with moisture, ascending from the great plains, with the descending currents of cold air from the snowy range, by which the moisture of the former is precipitated. As soon as the equilibrium is established, the rain passes off, and a sky more or less clear succeeds, followed almost invariably by clear nights and bright mornings. This series of phenomena, often succeeding with remarkable regularity from one day to

another, continues during the months of July and August, constituting a rainy season.

The principal object of my journey being the collection of plants, I may here very properly conclude this sketch of the general features of scenery, and climate.

The accompanying list of plants prepared from my collections, and notes, by Prof. Gray and Dr. Engelmann, will serve to give a more precise view of the botany of this region, particularly of the alpine district, to which my attention was specially directed.

Travelling over a path so ably investigated by early explorers, I have still been rewarded for my labors by the discovery of several interesting novelties, as well as by adding quite a number of alpine plants, well known in the Old World, to our North American Flora.

Should circumstances prove favorable, it is the intention of the writer to continue these observations during the coming season, over a wider section of country lying to the west and south of the investigations of the past season.

Enumeration of the Plants; by A. GRAY, *aided by notes of Drs.* ENGELMANN *and* TORREY, *and upon the habitats, &c., by Dr.* PARRY.

[The numbers are those under which the specimens have been distributed. Their order is followed, excepting a few transpositions to bring allied species together, when it could conveniently be done.]

1. *Erigeron grandiflorum*, Hook. Fl. Bor.-Am., t. 123; var. *elatius*. "In moist shady places, near the upper limit of the arborescent growth. Rays tinged with pink or purple." The specimens (a span to a foot in height) are considerably taller than Drummond's plant, from the summit of the Rocky Mountains much farther north, and the cauline leaves more clasping. Its affinities are with our American species of the section *Stenactis* on the one hand, and with the following species on the other, notably with the form named *E. alpinum* var. *eriocalyx* by Ledebour from the Altai.

8. *Erigeron uniflorum*, L., the true, with black-woolly involucre, like Bourgeau's specimens from the snowy region of the Rocky Mountains farther north. "Near the base of the bare alpine ridges."

3. Varieties of the last (one with blue, the other with nearly white rays), far less pubescent.

4. *Erigeron macranthum*, Nutt.

5, 6, 11, 33. *Erigeron compositum*, Pursh; different forms; the last smoothish and the same as *E. pedatum*, Nutt. No. 5 is a var. *discoideum*, wholly destitute of rays. Drummond long ago gathered specimens with very short rays. No. 33, is a single specimen of the same discoid variety.

7. *Erigeron acre*, L., var. Just the *E. Drœbachensis* of the Flora Danica, which we have from Labrador.

9. *Erigeron Bellidiastrum*, Nutt. A plant of the plains.

10. *Arnica angustifolia*, Vahl., var. *discoidea! latifolia.* There is a discoid species in California; but none of the common species have before been met with in this condition.

2. *Arnica cordifolia*, Hook.

12. *Boltonia latisquama* (sp. nov.): foliis lineari-lanceolatis et magnitudine capitulorum inter *B. glastifolium* et *diffusam* media; squamis involucri spathulatis vel obovatis nervo crasso excurrente mucronatis vel cuspidatis; pappo pluri-squamellato et 1–2-aristato. "Near the mouth of the Kansas river, Sept.; growing in large clumps, 3 to 5 feet high, in rich soil." Well marked by the broad and rounded, abruptly tipped scales of the involucre.

13. *Aster* (*Orthomeris*) *glaucus*, Torr. & Gray, (*Eucephalus glaucus*, Nutt.) Abundant and very fine specimens of a rare and interesting plant, by aid of which the species should be characterized anew.*

14. *Machæranthera* (*Dieteria*) *canescens*, Gray, Pl. Wright.

15. *Solidago Missouriensis*, Nutt., a dwarf, subalpine variety.

17. Another dwarf variety of the above species.

16. *Solidago humilis*, β, Torr. & Gray; to be restored to *S. Virgaurea.*

18. The var. *alpina* of the above (i. e. *S. Virgaurea*, *alpina*, Bigelow), resembling the plant from the summit of the White Mountains, New Hampshire, but only an inch or two high.

19. *Senecio aureus*, var. *Balsamitæ*, with leaves more pinnatifid.

20. *Senecio canus*, Hook., with few and large heads.

22. The same species with more numerous and smaller heads.

21. *Senecio lugens*, Richards., but the scales of the involucre not at all sphacelate at the tip.

23. *Senecio exaltatus*, Nutt., var. *minor.* A form of *S. lugens.*

24. *Senecio integerrimus*, Nutt. A rare species.

25. *Senecio triangularis*, Hook., in beautiful specimens.

26. *Senecio eremophilus*, Richards.

27. *Senecio Fremontii*, Torr. & Gray. Taller and well developed specimens of this alpine species, mostly a foot high.

28. A low, apparently more alpine variety of the preceding, with monocephalous stems, and leaves all tapering at the base.

29. *Palafoxia Hookeriana*, Torr. & Gray.

30. *Aplopappus spinulosus*, DC.

31. *Coreopsis involucrata*, Nutt. This, with the two preceding, and a specimen of *Pectis angustifolia*, Torr., were gathered on the plains.

32. *Arnica angustifolia*, Vahl; the tall, leafy-stemmed form common in that region, and approaching *A. Chamissonis.* Bourgeau collected the same on the Saskatchawan.

33, 35. *Townsendia sericea*, Hook.

34. *Cirsium edule*, Nutt.? "A common subalpine species, 3 to 6 feet high; flowers yellowish."

Cirsium foliosum, DC., or a plant generally agreeing with Hooker's character, was sparingly collected in the bare alpine region.

36. *Euphrosyne xanthifolia*, Gray, Pl. Wright. *Cyclachæna xanthifolia*, Fresen.

* *Aster Engelmanni*, Gray, coll. H. Engelmann, in Exped. Lieut. Bryan, I believe still unpublished, is another fine species of this section. The same was collected by Dr. Lyall of the British Oregon Boundary Commission, in the Cascade Mountains.

37. *Antennaria dioica*, R. Br. 39. Var. *rosea* of the same.

38. *Antennaria Carpathica*, DC.

40. *Iva axillaris*, Pursh.

41. *Artemisia borealis*, Pall.

42. *Artemisia Richardsoniana*, Bess. A form with looser pubescence and acute lobes to the leaves.

43. *Artemisia frigida*, Willd.

44. *Artemisia filifolia*, Torr. From the region where Dr. James first collected it.

45. *Artemisia Canadensis*, Michx.; a canescent form.

46. *Actinella aculis*, Nutt. Probably *Actinea integrifolia*, Torr.

47, 60. *Aplopappus* (*Stenotas*) *pygmæus*. *Stenotus pygmæus*, Torr. & Gray, Fl. 2, p. 237. "Found only on the highest crests of the snowy range, and on the dividing ridge, growing in scattered patches." A most interesting rediscovery of a plant before known only from a single specimen, gathered by Dr. James during his hurried visit to the alpine region, in Long's Expedition.

48. *Grindelia squarrosa*, Dunal.

49. *Limosyris viscidiflora*, var. γ. *L. ciliata*, Torr. &c.

50. *Helianthus* (*pumilus*, Nutt.?): caule 1–3-pedali hispido oligocephalo; foliis oppositis ovato-lanceolatis subintegerrimis cinereo-hispidis (novellis resinoso-atomiferis) juxta basin triplinerviis breviter petiolatis, summis lanceolatis subsessilibus sæpe alternis; involucri disco paullo brevioris squamis oblongis exappendiculatis obtusiusculis vel breviter acutatis extus albo-villosis; fl. disci luteis; acheniis glabris versus apicem parce hispido-ciliatis; pappi paleis subulatis corolla paullo brevioribus cum paleolis interpositis extus marginibusque appresse hispidis. "On a rocky hill bordering the upper Clear Creek." Dr. Hayden also collected it on the Laramie Mountains. His specimens, being too far advanced, I had confounded with *H. rigidus;* but the plant is nearer *H. lætiflorus*. If it is not Nuttall's obscure *H. pumilus* it must be a new species. The latter is said to have the heads "apparently sessile," from which it may be inferred that they were not well developed in Nuttall's specimen. In ours they are on slender peduncles.

57. *Helianthus orgyalis*, DC. This seldom occurs in collections.

51. *Aplopappus* (*Pyrrocoma*) *Parryi* (sp. nov.): caule pedali superne subviscoso-puberulo apice corymboso-polycephalo, pedunculis brevissimis; foliis submembranaceis fere glabris angusto-oblongis obtusis integerrimis, inferioribus subspathulatis in petiolum attenuatis, summis basi latiore subamplexicaulibus; involucri campanulati squamis lato-lanceolatis tenuiter coriaceis apice subfoliaceo laxo; ligulis plurimis parvis; acheniis glaberrimis; pappo albo haud rigido. "Hillsides and pine-woods, upper Clear Creek." A well-marked species, with somewhat the aspect of a *Sericocarpus*, especially of *S. Oregonensis;* heads half an inch long; the rays 15–20, yellow, narrowly linear, but little longer than the disk-flowers. Pappus white in the flowering specimens (unknown in the mature state) nearly equalling the disk-corollas. "These specimens grew in the shade; in open ground the leaves are not so thin."

52. *Senecio cernuus* (sp. nov.): mox glaber; caule gracili sesquipedali apice paniculato-polycephalo; foliis lanceolatis basi in petiolum

marginatum subciliatum longe attenuatis parce argutissime dentatis vel subintegerrimis; capitulis parvulis (vix semi-pollicaribus) in pedicello 1–2-bracteolato nutantibus discoideis; involucro bracteolis parcis laxis subcalyculato; ovariis glaberrimis. "Dry hillsides, and in the crevices of rocks, upper part of Clear Creek, sometimes growing in close bunches." A species entirely new to me, well marked by its small nodding or cernuous heads, and its leaves (either broadly or narrowly lanceolate) tapering into wing-margined petioles of an inch or two in length. No ray flowers; those of the disk yellow.

53. *Arnica mollis*, Hook.? a dwarf form.

54. *Arnica angustifolia*, Vahl; the alpine form, as of the Rocky Mountains farther north, and of the N. W. coast.

55. *Chænactis achilleæfolia*, Hook. & Arn.

56. *Senecio amplectens*, (sp. nov.): lana parca mox decidua glabratus; caule (sesquipedali e radice perenni) apice nudo 1–2-cephalo; foliis membranaceis repando-subdentatis oblongis plerumque obtusissimis, radicalibus in petiolum alatum decurrentibus, caulinis præsertim superioribus e basi lata (integerrima vel utrinque 1–2-dentata nunc subhastata) semi-amplexicaulibus; pedunculo gracili; involucro calyculato pilis brevibus atropurpureis parcis munitis; ligulis elongatis linearibus aureis apice sæpius 2–3-fidis; acheniis glaberrimis. "In the mountains high up, at the foot of the snowy range." This is quite distinct from any North American species known to me. Compared with *S. frigidus*, it is far less woolly, even when young, and not at all hairy, except some purple hairiness of the involucre; the latter is calyculate with linear scales of about one-third the length of the proper involucral scales; and the thin and green leaves are from 3 to 5 inches long, the cauline ones half clasping or more by a broad base, not at all inclined to be spatulate. Head nearly as large as in *S. frigidus*, the rays longer, an inch or more in length. Pappus equalling the disk-flowers.

58. *Villanova chrysanthemoides*, Gray, Pl. Wright; a more pubescent form.

59. *Chrysopsis villosa*, Nutt., var. approaching *hispida*, *mollis*, &c., all probably forms of *C. villosa*.

61. *Actinella grandiflora*, Torr. & Gray in Bost. Jour. Nat. Hist. Soc., 5. "Scattered over the alpine ridges, growing singly or branched from a deep tap root, 6 to 9 inches high." A most splendid dwarf alpine plant, which, having caused seeds to germinate, I hope to introduce into the gardens. The heads, with their numerous rays fully expanded, are nearly 3 inches in diameter, and bright yellow. It was before known only by the single specimen gathered by Fremont, in Dr. Torrey's herbarium.

62. *Gaillardia aristata*, Pursh.

63. *Senecio aureus*, L., var. *alpinus:* caule scapiformi 1–2-cephalo tripollicari bracteato; foliis radicalibus coriaceis rotundatis seu obovato-oblongis fere aveniis integerrimis vel apice subtridentatis. This doubtless was collected near the snow line. I believe it is an alpine and extremely reduced form of *S. aureus*, var. *borealis*, and that *S. subnudus*, DC., may also be reduced to *S. aureus*.

64, 66. *Macrorhynchus troximoides*, Torr. & Gray; broad-leaved and narrow leaved.

65. *Troximon glaucum*, Nutt., var. foliis laciniatis.

67. *Troximon parviflorum*, Nutt. Probably a depauperate form of the last.

68. *Lygodesmia juncea*, Don.

69. *Crepis runcinata*, Torr. & Gray.

71. *Hieracium Fendleri*, Schultz Bip. in Bonpl. 1861, p. 174. *Crepis ambigua*, Gray, Pl. Fendl.

72. *Hieracium triste*, Willd.

73. *Mulgedium pulchellum*, Nutt.

74. *Atragene alpina*, L.: the same as Fendler's, i. e. var. *Ochotensis*.

75. *Thalictrum alpinum*, L. Very rare as an American plant, found before only on the eastern borders of this continent, Anticosti, &c.

76. *Thalictrum sparsiflorum*, Turcz.; vide Gray, Pl. Wright, adn. p. 8: forma ovariis breviter stipitatis unacum pagina inferiori foliorum resinoso-atomiferis. Maximovicz, commenting in the Flora Amurensis upon my identification of *T. clavatum*, Hook. (non DC.) with *T. sparsiflorum*, indicates a difference between the American and the Siberian plant in the length of the filaments and of the stipe. The latter is variable; the former is subsexual; both short and long filaments occur in Richardson's specimens. I am able to compare the fruit of a Hudson's Bay specimen with that of one of Tilings, of the Fl. Ajanensis, and to pronounce them precisely alike. In the latter the leaves are resinous-atomiferous underneath, as they are in Dr. Parry's specimens, in which similar atoms thickly beset the carpels. The oval sepals appear to be white. *T. Fendleri*, Engelm., from the mountain region farther south is really much allied to this; but that has diœcious instead of hermaphrodite flowers, linear and conspicuously pointed instead of barely oblong anthers, the achenia oblique (instead of dimidiate) and sharp-edged, the ribs straighter and stronger.

77. *Ranunculus affinis*, R. Br.

78. *Ranunculus Cymbalaria*, Pursh.

79. *Ranunculus glaberrimus*, Hook.; var. foliis omnibus integerrimis, radice magis fibrosa. Mr. Spalding's specimens from the interior of Oregon connect this with Hooker's species.

80. *Ranunculus Eschscholtzii*, Hook. (an Schlecht.?) But perhaps an alpine form of No. 77. Some specimens under this number, with finely-cut leaves tend to confirm this suggestion.

81. *Ranunculus amœnus*, Ledeb.? I have before seen no American Ranunculus like this. It accords well with an authentic specimen of *R. amœnus*, but not so well with Ledebour's figure. This species has been joined by Ledebour himself to *R. affinis*, to which I should never think of referring our plant, with its large and very broad, overlapping petals. The fruit was not collected. It grows "in the high alpine region, in scattered patches near snow-banks: fl. June."

82. *Clematis Douglasii*, Hook.

83. *Trollius laxus*, Salisb., var. *albiflorus*. *T. Americanus*, Hook. Fl. Bor.-Am. "In moist or marshy places below snow-banks, associated with No. 91, June 21. Stem 6 to 12 inches high. Flowers white: these often frozen to a crisp recover perfectly in bright sunshine." The

pure white and broader sepals, lower stature, and alpine station, distinguish this from the ordinary form of the Northern United States. Regel in Fl. Ajan., reduces all the proposed species of this group to three, with many varieties, some of them too closely connecting *T. patulus* with the American species.

84. *Delphinium elatum*, L., a species which doubtless includes *D. intermedium*, *palmatifidum*, *flexuosum*, *villosum*, and *cuneatum*, DC. Also, I suppose, in part *D. exaltatum*, Hook. Fl. Bor.-Am., being more like that species than the next is; but it is not the plant of our Alleghany region. Like most of the present collection, the specimens are particularly good and neatly prepared. "It grows in large patches, on the moist borders of alpine brooks, near the limit of arborescent growth. Stem 3 to 5 feet high, the flowers vivid blue-purple."

85. *Delphinium scopulorum*, Gray, Pl. Wright. This is the same as one of Bourgeau's collection from the Saskatchawan, distributed as *D. exaltatum*. The spurs on the *lower* petals appear to be constant.

86. *Aconitum nasutum*, Fisch. (*A. Columbianum*, Nutt.) "Two very distinct varieties, one, 1½ to 3 feet high with greenish white flowers, growing in shady places along the borders of streams; the other with deep blue flowers, in more open places, not so tall, and inclined to twine about adjacent bushes."

87. *Anemone multifida*, DC., with both red and white flowers.

88. *Pulsatilla Nuttalliana*, Gray.

89. *Aquilegia cærulea*, Torr. Most beautiful specimens, from the district where Dr. James discovered this striking species. Limb of the petals apparently white, contrasting with the purple-blue sepals: spurs 2 inches long.

90. *Aquilegia vulgaris*, L., var. *A. brevistyla*, Hook. In the high alpine region.

91. *Caltha leptosepala*, DC. Borders of alpine brooks, with No. 84, &c.

92. *Thlaspi cochleariforme*, DC.? Hook., *T. Fendleri*, Gray, Pl. Wright. Although the silicle is less winged than in Delessert's figure, it is likely that the plant of the Rocky Mountains is not distinct from the Siberian; but I have not yet seen the evidence to justify its combination, as Dr. Hooker proposes, with *T. montanum* and *T. præcox* as well as with *T. alpestre*.

93. *Draba Johannis*, Host. (*D. nivalis*, DC.) Probably to be included among the forms reduced to *D. hirta* in the Fl. Ajanensis and elsewhere. In the high alpine region.

94. *Turritis patula*, Graham.

95. *Erysimum pumilum*, Nutt.; but the stigma is two-lobed or emarginate. "In the alpine region, low; flowers light sulphur-yellow." This may really be identical with Gaudin's *E. pumilum*, of the Swiss Alps, and it has equally a slender style and erect siliques. But it appears to pass into our *E. asperum* just as *E. pumilum* does into *E. Cheiranthus*. Not a single species of this group of *Erysimum* is well defined.

96. *Draba streptocarpa* (sp. nov.): radice § Holargis more bienni vel subperenni rosulam amplam caulesque floridos foliatos (spithamæos) proferente; foliis integerrimis setis simplicibus et bifurcatis villoso-hispidis, radicalibus spathulato-lanceolatis acutiusculis in petiolum marginatum longe attenuatis, caulinis sessilibus; racemis sæpe paniculatis; pet-

alis aureis calyce duplo longioribus; siliculis linearibus (vel imperfectis oblongo seu ovato-lanceolatis) hispidulo-ciliatis cæterum glabris, maturis eximie spiraliter tortis; stylo longo.—Forma vero *alpina* bipollicaris, siliculis (immaturis) brevioribus. "On rocky cliffs bordering the upper Clear Creek, extending into the high alpine region, where the dwarf form was found in flower in July, while the larger form lower down was mostly with ripe fruit." A most interesting species, allied to *D. aurea*, and with similar bright yellow, mostly retuse or emarginate petals. The leaves appear as if veinless, except the strong midrib, are all entire, and are beset, and especially ciliate, with long and rigid, shaggy, spreading, simple or simply forked hairs, far more bristly than in *D. aurea*, and with no fine stellular pubescence intermixed. Leaves of the radical clusters ¾ to 1½ inches long; the cauline ones half an inch or so in length, oblong or oblong-lanceolate, the upper ones on their upper face, like the upper part of the stem, sometimes becoming glabrous. Racemes many-flowered. Style a little shorter than the ovary; stigma emarginate-capitate. Fructiferous pedicels 3 lines long, more or less spreading. Silicles when well developed from half to two thirds of an inch long, either minutely or strongly hispid-ciliate, and twisted like an auger, the turns 3 or 4; but many of them, especially the later ones, are shorter and with only one or two twists: the style 1½ to nearly 2 lines long.

103. *Draba aurea*, Vahl, Hook. A form with smaller and narrower leaves than in Hooker's figure, and with simple elongated racemes. It accords very well with the plant cultivated several years ago under this name in Kew Gardens, and has a similar (at most biennial) root. *Draba* No. 6, of Bourgeau in Paliser's Expedition, is apparently the same; while Burke gathered in the Rocky Mountains specimens agreeing with Hooker's figure. All have a short and fine pubescence, and minutely hoary, plane or slightly twisted silicles, the style from a line to a line and a half in length. But, as in other Cruciferous plants, no great reliance can be placed on the length of the style. In New Mexican specimens, var. *stylosa* (*D. aurea*, Pl. Fendl., No. 43, p. 10, and in coll. Bigelow, Pacific R. R. Rep. iv, p. 66,—both ramose forms), the style is quite as long as in *D. streptocarpa*. I have seen no Greenland specimens.

Draba alpina, L.; a form apparently of this species, with one or two leaves on the scape, and a rather conspicuous style, was gathered on the summit of the snowy range.

97. *Draba nemorosa*, L.

98. *Arabis hirsuta*, Scop.

99. *Cardamine cordifolia*, Gray, Pl. Fendl.

100. *Sisymbrium canescens*, Nutt.

101. *Physaria didymocarpa*, Gray (*Vesicaria didymocarpa*, Hook.): var.? racemis fructiferis elongatis; siliculis minoribus corrugatis minus inflatis. "Dry gravelly bluffs of upper Clear Creek, growing in bunches a foot in diameter: the vegetation more luxuriant than *P. didymocarpa* of the plains, of which it is probably only a mountain variety." If so, it is a remarkable one. There is an unpublished species, *P. Newberryi*, allied to *P. Geyeri*, collected by Dr. Newberry in the interior of New Mexico.

102. *Erysimum asperum*, DC., the form with orange-colored flowers, *E. Arkansanum*, Nutt., collected on the plains.

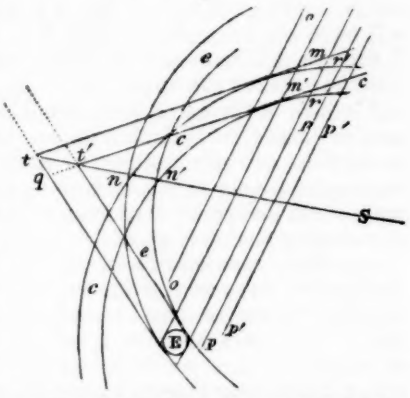
ART. XXVI.—*Investigations respecting the Phenomena of Meteoric Rings, as affected by the Earth;* by ALEXANDER C. TWINING.

THE object of the proposed investigations is a practical one. It is, principally, to lead the way towards determining certain questions relating to the phenomena of periodic meteors—especially the meteors of August 9th–11th; only, however, by the simplest methods consistent with an essential accuracy, and in the hope that these phenomena may thereby be made to an increased extent the objects of intelligent observation at the times of their annual appearance. Of the questions referred to one relates to the effect of position on the Earth's surface upon the apparent "radiant" as observed from that position,—and another relates to the changes of radiant in latitude and longitude, from day to day, during the earth's passage through the body of the ring. If the changes mapped from my own observations upon the chart published in the last November No. of this Journal are admitted and shall be confirmed by farther observation as a fact constantly occurring, it will become an interesting enquiry, to what cause those changes can be or cannot be referred,—whether to perturbations occasioned by the Earth directly, or whether they are to be explained by an existing and permanent constitution of the ring deducible by analysis, as a cosmical effect, from the planetary influences. This latter enquiry however, although I thus state it in full, covers it will be seen, a vastly greater area than all which lies within the present purpose and discussion. A meteoric ring is, of course, the subject of influence from all the planets, through their entire revolutions. But these unintermitting influences of the general system are clearly distinguishable from the special and immediate effects and results of the Earth's conjunction with and penetration of the ring. Only the latter will be treated of in the following theory,—which is intended, however, to embrace them in one simple and elementary view and discussion.

Let S be the sun, E the earth, E *e e* the orbital space or track of the earth in its annual revolution, and *c c c* the corresponding breadth of a meteoric ring intersected by it. Although our results are independent of any particular hypothesis respecting the primary constitution of the ring, yet, for convenience, the meteoric orbits are supposed primarily all parallel, one to another, in the parts at and near the nodes on the ecliptic *c c c*; a supposition which includes, as a consequence, the mutual intersections of those orbits in or near a line passing through S and normal to the mean line of nodes S *n t*. Let E *t*, E *t'* be tangent to the exterior and interior bounding circles of E *e e*, and let *m*, *r*, be meteors which if undisturbed by the earth, would find their

nodes at n, n', and would there meet the earth's circle E at the tangent points. Let $m\,t$, $r\,t'$ be tangents at m and r to the orbits of those meteors: then E t and E t' will be intersected in t and t' by either those tangents or by others which approximate to them with extreme closeness; for, because of the small length of the arcs E n, E n' and m n, $r\,n'$, compared with the radius vector E S or m S and r S, the sun's action upon the meteors and upon the earth may be considered the same, both in amount and direction, as will more fully appear in a subsequent paragraph, and by discussing separately the inequalities introduced by that supposition. Also, on account of the near proportionality of those tangents to their arcs, as well as their near approach to the same in magnitude, if E t represents the earth's velocity in that tangent, $m\,t$ will equally represent the velocity of m in the latter tangent. Both the earth and the meteor would therefore meet in t if undisturbed; and, inasmuch as the two are affected alike by the sun's attraction they will, in fact, meet in n, fulfilling accordingly the condition which alone is required to constitute $m\,t\,m'\,t'$ true tangents. In other words if the earth and a meteor considered as mere points in their respective orbits will in fact meet, then, under the supposition that the solar influences upon both have been the same in amount and direction, the same points would have met by their motion uniformly continued—that is to say the respective tangents meet. The same concurrence may be shown in respect of E t' and $r\,t'$; so that the planes E $m\,t$ and E $r\,t'$ may be taken as parallel and as continuing parallel to their first positions, although moving with the points E, m, t, or E, r, t', as those are moved by the sun's attraction. Under such a representation of the two velocities, E m represents also, both in amount and direction, the velocity of m relatively to E,—also r is moving with the same relative velocity in the parallel E r. It is also desirable to notice that if m' is a meteor intercepted by the relative line E m, and if $m'\,q$, parallel to $m\,t$, intersects E t in q the meteor m' and the line $m'\,q$ bear the same relations to the orbits of E and m' and to the plane E $t\,m$ which E and m and the tangent E t will bear to the same when E shall have advanced a distance equal to

1.



$q\,t$. Therefore the node q' will be in the same orbital circle E n e with the node n; and the same is true of every meteor intercepted by the line E m in any part of it. In like manner if r is a meteor intercepted by the line E r' in the plane E t' r its node will be in the same orbital circle E n' e with n'. Moreover, when E shall have advanced and intercepted m in n, a meteor which shall have taken the exact place occupied by m as first supposed and which, at the same time, should be affected with the same motion parallel to t S which the sun has imparted to E and to m in the time of their passing to their common node, would be moving relatively to the earth in its present and acquired motion truly in the line E m. By so much therefore as the line E m would be varied in position by compounding with it twice the subtense $t\,n$ set off in parallelism with t S, by only the same do we vary the relative directions of the two meteors one of which is at m and the other at the same instant at n. If now E n is taken an arc of three days description, or in round numbers five millions of miles, and E m—in the instance of the August periodic meteors at least—about seven millions (and in the instance of the November periodic meteors unquestionably still greater,) we have the double subtense $t\,n$ but little more than one quarter of a million; which, applied to E m, is but $\frac{1}{2}\frac{1}{5}$th part and gives but 2° of variation from the parallels. But m is now at an extreme of distance, being four millions of miles when nearest. At this distance the earth's disturbing force being but one millionth part of gravity at the surface we arrive at the conclusion that the initial relative velocities of all meteors originally parallel and equal in their absolute motions may be safely treated as parallel within the limits of this class of disturbances on every side of the earth and under the conditions supposed in this article. (A)

Moreover the errors involved in the supposition above alluded to are but trifling, as will readily appear by a brief consideration of them separately. Referring anew to figure 1, if the sun's action were, as above supposed, accurately the same in amount and direction upon both the meteor m and the earth, those bodies would remain accurately in the tangents E t, $m\,t$ respectively and in the moving plane. In fact however the action is a little oblique. This circumstance, it will appear, does not in the least vary the fact that the bodies will meet in the line t S at one and the same instant, although not necessarily in one and the same point of meeting as before. For, considering the distances E S and m S equal, and of consequence the solar attractions equal—and perpendiculars dropped from E and m upon the line t S we have the velocities of the bodies, when resolved in a direction normal to t S, proportional to those perpendiculars; because they will meet in t S and their uniform velocity is unaffected by

forces parallel to tS. But the same perpendiculars, throughout their changes of magnitude, represent the forces of obliquity respectively, and therefore the velocities, however accelerated, continue in a uniform ratio to one another and to the distances remaining to be described. Therefore both meet the line tS at the same instant; and since they have been subject only to equal and parallel forces in the direction tS, they will not be disturbed as to relative motion except by a fraction of the normal force above considered, and that fraction ordinarily a small one. For, in fact, if the arc En is five millions of miles as above considered, the fraction $\frac{1}{4}\frac{1}{0}$th will express nearly the amount of solar force exerted obliquely upon E,—competent therefore to impart a velocity of but $\frac{1}{2}\frac{1}{0}$th the subtense tS in the same time and $\frac{1}{8}$th only of that available as a disturbance of the relative velocity in direction—being, in relation to the August meteors, only $\frac{1}{5}\frac{1}{0}\frac{1}{8}\frac{1}{0}$th part of that relative velocity. This evidently is insensible in relation to disturbances of the earth which depend upon the direction of relative motion.

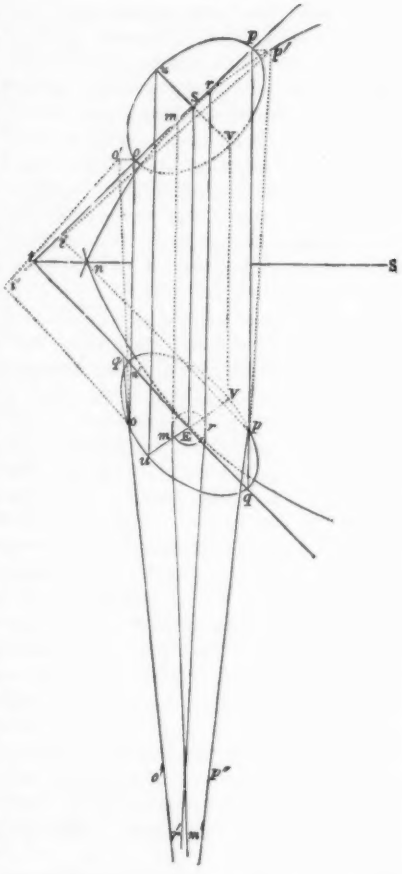
Passing to the error introduced by the supposition that the solar forces upon E and m are equal—and which arises by neglecting the difference of radius vector mS from ES—it is not necessary to assume imaginary or improbable amounts for that difference. For an arc nm of four millions and a half of miles the angle of the chord and radius vector for the August meteors, it would appear from the computations of Prof. H. A. Newton, may be taken at about 76°; and if even only 70° were supposed, we obtain but $\frac{1}{6}\frac{1}{4}$th as the fraction of solar force acting in excess or in defect of the whole. The corresponding difference or fraction, in the instance of the November periodic meteors is evidently still less than the last named, and, in fact, scarcely worthy of estimation. And—besides that it is compensated, as respects any permanent displacement, during the recession of the meteors—this inequality becomes of the less significance, that its effect lies in tS or parallel to it, and therefore is presented in the plane Etm and laterally to the line of force in which the earth acts. For this reason the perturbations of the earth are scarcely modified by the effects in question,—but only this result takes place, that the meteor which meets E at the tangent point of Et and in n, is not m, as it would be conformably to the idea of a perfect parallelism of solar influence, but it is a meteor corresponding to m in distance and place, except that it lies somewhat forward or somewhat back of the moving or relative plane Etm, but reaching E with the same effects of perturbation in both cases.

We therefore reaffirm the foregoing conclusion, that, for the simple purpose of ascertaining the species and amount of those effects upon the constituent meteors of a ring which are due im-

mediately to the earth's conjunction with the ring, we may investigate the orbital effects upon all meteors within a cylinder extending to the utmost appreciable extent of immediate or extraordinary terrestrial influence considering the relative motions equal and parallel to an axis—as it may be termed—of the cylinder passing through the earth's centre. (B)

Let then the cylinder of influence, so to call it, be represented in figure 2 by its bounding curves and surfaces upon the ecliptic, as *o u q p v*–and upon a plane of the meteoric ring, as *o v p′p u*, and the contained lines *o o*, *u u*, *p p*, *v v*, which also represent the parallel relative lines of approach of the meteors *o*, *u*, *p* and *v* to the earth, or the asymptotes of their orbits. The axis is E *s*. The plane E *m t* is the same as designated by the same letters in figure 1, and *o o s p q* E is a section by that plane, and *u u s v* E is a section perpendicular to it. The lines *m m*, *r r* represent the asymptotes of two orbits touching a circle or section of any definite extent from the earth's centre E, in the plane E *m t*.

2.



Now the meteors *m* and *r* will be made to describe around the earth similar orbits whose asymptotes, pairing with *m m* and *r r* respectively, will be *m m′ r r′* somewhere crossing (if sufficiently disturbed) beyond the earth, or else made to incline towards one another—as *o o′* and *p p″* which represent asymptotes pairing with *o o* and *p p* respectively, and belonging to the orbits of *o* and *p*. Now if the section *m* E *r* and the asymptotes *m m*, *r r*, were in

the plane $u\,r$, normal to the first, or in any plane of intermediate position, their orbits would be unchanged except as to the plane of their description; and the same is true in a like comparison of all orbits of meteors at one and the same distance from and around the axis E *s*, whatever the plane passing through E *s* in which their orbits are described. If the earth is considered a sphere, and if $m\,\mathrm{E}\,r$ represents the extreme circle or elevation at which, under given conditions of observation, the phenomena of meteoric flights are visible, it is an obvious conclusion that *all perturbations occasioned by the earth, and consequently all the changes in radiant positions observed, from the earth, obey a regimen in relation to the axis* E *s alike and equally on every side; and, relatively to that axis, take effect directly away from it, and in the plane common to it and to the meteor's orbit.* It should also be observed, in passing, that the same proposition holds true even in respect to the aberrations occasioned or that may be supposed to be occasioned by the atmosphere itself, so far as those are normal and not the effect of irregular forms of meteors or accumulations of air. For the axis E *s*, whether occupied or not by any meteoric flight E *s*, does always obtain—and always in exact symmetry with the atmosphere on every side in any normal condition of the latter.

We now pause briefly to consider whether the above perturbations and consequent diversities of radiant positions in the celestial sphere are considerable enough, in the instance of the August meteors, to be detected by comparative observations.

In $m\,\mathrm{E}\,r$ taken as a true circle one hundred miles above or outside of the earth's surface, and therefore 8112 miles in diameter, let m and r be meteors, and the orbit of one, as m, be represented by its asymptotes $m\,m$, $m\,m'$, the initial and terminal points of which are at an equal distance from E, and that distance at an extreme—say seven millions of miles. Let v be the velocity of the meteors supposed uniform at that distance,—that is, 26·6 miles per second, as determined from the observations of Mr. Marsh, Mr. Herrick, and myself, by Prof. H. A. Newton,—and let p be the perpendicular distance from E to $m\,m$. Then $\frac{p\,v}{2}$ is the area described by the meteor's radius vector in a unit or second of time. Also the area described in the same unit by a body revolving, at the distance p, in a circle may be called $a\sqrt{p}$, the value of a being 154·52. Then the latus rectum of the orbit (hyperbolic in form) will be expressed by the formula $\mathrm{L}=\frac{p^2v^2}{2a^2}$. Let z be the distance of the apsis from E, and the velocity at the apsis will be $(v^2+f\frac{1}{z})^{\frac{1}{2}}$, in which f has the value

191,003, and z becomes known by the equation $z^2+\frac{f}{v^2}z=p^2$ or $z=3923$. And if x and y are the transverse and the conjugate axes respectively they are measured by the formulas $x=\frac{4z^2}{L-4z}$, $y=2(\frac{Lz^2}{L-4z})^{\frac{1}{2}}$:—therefore x is 270, and y 8112. Consequently the angle of the asymptotes is 3° 49′, which is also the angular deviation of m and r compared together in their lines of motion taken at their apsides.

It appears therefore *that the variations of radiant position, for the meteors of August 9th–11th cannot exceed* 3° 49′, *and may, in the comparison of extremes, approach to that amount.* It is obvious that the axis itself changes place continually in a circle of latitude in consequence of the terrestrial rotation,—so that to the view of a single observer the hour of day is productive of a change of the radiant's position, although observation may not ordinarily be close enough to detect it.

If we enquire into the general effect upon the mass of meteors at great distances from the earth, we have simply to observe that in the formula $x=\frac{4z^2}{L-4z}$, inasmuch as L varies as the squares of the areas simultaneously described, and therefore as p^2 or y^2, and is also equal to $\frac{y^2}{x}$, the latter varies as y^2,—that is to say x is constant. But y is equal to p. Consequently the small angular deflection of asymptotes will vary in the inverse ratio of p. If half the above distance, or 4056 miles, is taken unity, and D is any other distance in any axial plane, the average effect upon all meteors in that plane and to that extent will be, in minutes, $229'\frac{\log. D}{D-1}$; so that for half a million of miles extending on either side of the earth the average deflection would be 9′. But for the entire circle the same would be approximately $229'\frac{2}{D}$, or for the entire cylinder of one million of miles diameter, the average permanent deflection would be $3\frac{3}{4}'$, which is the average estimated in all directions taken in the aggregate. But if estimated in a single direction only the same average would sink to only $2\frac{1}{2}'$. These quantities are meant to give some idea of the effect upon large masses or assemblages of meteors; which, however, after all, form only small fractions of the entire ring.

It will be observed that those orbits which are nearest to the earth will cross one another; and that others still will cross at distances varying all the way from one-fourth of the distance of the moon to many millions of miles. And, since the deflection of tangents or asymptotes diminishes almost exactly as the per-

pendicular p increases, the places of crossing will lie more and more distant behind the earth in the ratio of the square of that perpendicular. But the numbers crossing, if the meteors are distributed equably in the ring, increase in the same ratio, or as the square of p,—consequently the numbers vary as the distances through which the crossing takes place. By this it appears that the earth, at each conjunction with the ring, leaves behind itself, to a certain extent, a kind of *wake*, or line of *equable condensation*—as it may be called—which would shortly disappear, and only reappear when the same meteors shall again have just passed their nodes; but which, for aught that appears to the contrary, may by successive conjunctions occurring in different parts, during say 5000 years, come to occupy a permanent position forward of the nodes, and to possess a uniform constitution. (C)

The foregoing discussion of *relative* motions and effects gives a key to the absolute and resulting perturbations, so far as the latter are primary and immediate, and exhibits the principles upon which formulæ may be constructed which shall measure the effects upon inclination, velocity, motion of nodes, and magnitude and form of orbits. For if in the plane E t m the orbits of two meteors o and p are represented by their asymptotes ooo'' and ppp'' equally distant from E, and if $p''p$ is produced back in pp', and $o''o$ in oo' and if oi' and pi are the lines of common section of E t m with planes parallel to the ecliptic, then from similarity of the triangles E t m, $oi'o$ and pip it appears that if oi', oi' represent the real motion of the earth and of the meteors respectively oo will represent their relative motion; and in like manner pi, pi and pp, may represent the same in pip. Now the terminal relative motion in o'' and p'' is the same in amount as the initial motion in o and p, and is represented by oo' equal to oo and pp' equal to pp. And, inasmuch as the asymptotes of the meteors o and p intersect in their relative position the lines $i'o$, ip respectively, the lines of real motion must intersect in i' and i. Join $i'o'$ and ip' and they will represent the real motions possessed by the meteors o and p after they have receded into the ring and are no longer subject to a sensible disturbance. Also ooo' and ppp'' are, with due reductions in a plane truly normal to the ring, the changes of inclination. Let the arc of ooo' and of its equal ppp' be called A. Now, as the sides of the similar triangles and the angles are known from observed data, if we represent the angle E st by B we obtain $p'ip$, and $o'i'o =$ A cos. B $\frac{pp}{ip'}$ and A cos. B $\frac{oo}{i'o'}$ respectively,—and if the initial velocity is called unity, the resulting velocities will be $1 \pm \frac{\text{E}s}{st}$ tan. A sin. B very nearly—the positive sign applying to pp and the

negative to *o o*. For the August ring we may take $ts = 1$, and $Es = 1{\cdot}6$ and $B = 45°$, and A is found in (C) 229′, consequently the change of inclination in opposite directions for *o* and *p* will be over 4°, and the changes of velocity $1 \pm {\cdot}0755$. These numeral determinations, it will be understood, apply simply to orbits whose asymptotes pass 4056 miles from the centre; for the more distant orbits they would apply in the inverse ratio of the corresponding distance.

The foregoing effects take place in E *s t*. Attending next to those in the normal plane *u v*, in which plane we will now suppose *m m* and *r r* to lie, and at the same distance or circle *m* E *r* as before, we may assume that the deviations of relative motion take place in lines perpendicular to E *s t* at the points *m* and *r*. This class of deviations therefore leaves velocity unaffected, and takes effect nearly in the plane of the meteors' solar orbits. It simply changes the line of apsides and angle of the tangent with the radius vector; and, diverging outward from *s*, it affects the perihelion distance in opposite senses—enlarging the same for *m m* and the orbits upon the same side of E *s* with it and diminishing those on the same side with *r r*. The expression for this angular effect in the meteoric plane is simply $\pm A \frac{Es}{st}$ or, at an extreme for the same conditions as above, $\pm 6° 6'$; and for other distances inversely as the distance. (D)

Two separate effects therefore in the separate planes contribute to modify the meteoric orbits and at the same time to shift the radiant positions. For, referring anew to figure 2, we find in E *s t* that a meteor, as *m m*, on the side *preceding*, undergoes both a depression of tangents towards the ecliptic and a contraction of orbit; while in *u v* the meteors of the side *following*—as *v v*—are contracted as to perihelia, and advanced in longitude as to their tangents. On the opposite parts or sides effects precisely opposite are realized. In planes having an intermediate position between E *s t* and *u v* the two classes of effects in different degrees accumulate upon one another or abate one another according to the quadrant's situation and their position in the quadrant.

Referring now to the effects in the plane *u v* and observing the angles of radius vector with the tangents to become 84°, in the case of *m m*, and 72° in the case of *r r*, and with the velocity 16·8 miles per second, while that of the earth is 18 89, we obtain for the perihelion distances 0·63 and 0·52. By this it appears that the perihelion is shifted, at the extremes of distance, more than ten millions of miles. It will be recollected that those meteors which have the less perihelion distance are also those whose radiant at the earth would have the greater longitude. The line of apsides also experiences a change between the extremes of 21° and 39° south of the ecliptic.

Turning now to the effects in the plane E *s t*, we find the elements in part for the meteors above designated as *m m* on the side *preceding*, and *r r* on the side *following;* viz.

Transverse axes,	1·51	and	1·84
Perihelion distances,	0·47	and	0·72

This perturbation therefore expands the ring to an extreme breadth at the ascending nodes of about twenty-four millions of miles, and—admitting the sufficient exactness of our data—throws it closely up to the orbit of Venus. It will be remembered that the meteors which have the extreme perihelion distance have also the higher latitude and elevation for the radiant at the earth. (E)

Our discussion includes also the motions of nodes. Referring to figure 1 it will be observed that while the meteors *m* and *m'* or *r* and *r'* are in the same line of flight *m* E, yet their nodes upon the ecliptic are separate, one from the other, and are distant by the line *q t*. But *m'* reaches *q* in the same time with E and *m* reaches *t* likewise simultaneously with E. Therefore the nodes of *m'* and *m* are separated by the distance moved by the earth in the interval between the arrival of *m'* at its apis and the arrival of *m* at the same. Transferring our attention to figure 2 and supposing the initial places of *m* and *r* in their orbits to be equidistant from their apses with the corresponding terminal places *m' r'*, after the meteors have receded into the ring away from the earth's immediate influence, it is obvious that the meteors in their orbits have reached *m'* and *r'* earlier than they would by their uniform motion through *m m*, *r r*, and (at the centre of their hyperbolas experiencing an instantaneous inflection) by the same motion continued to *m'* and *r'*. By whatever space the earth would have advanced in that interval, by just that space will the nodes have retrograded on the planes parallel to the ecliptic passing through their orbital centers above referred to.* It is noticeable that this retrogradation takes effect alike and equally on every side of the earth and to an amount depending only upon the distance from E. The position of the orbital centres, above and below the ecliptic, and in the quadrants *v* E *q'*, *u* E *q'*, &c. modify this effect when referred to the ecliptic. Thus if *o* E *p* is a line normal to the relative lines *p p*, *o o*, &c. *p* will at the orbital centre, lie above the ecliptic, and *o* beneath it. Therefore in the plane E *s t* the nodes are thrown forward by the small distances *n q*, *n' q'* which are nearly equal. Moreover this distance is the same, very nearly, for *r r* as for *p p*, and for *m m* as for *o o*, because the small angles *n p q*, *n' o q'* have a magnitude inversely as the distance of their angular points from E,—see (C)—and consequently inversely as the distances of the same

* The small reduction to the ecliptic may be neglected.

from the ecliptic. But in the plane $u\,v$, such is the direction of the deflections or effects in the line $u\,\mathrm{E}\,v$ that, even if the radial distances were not in or near the ecliptic, neither a retrocession nor an advance can be consequent upon them.

Resuming the expressions and quantities from (C); viz. x and y the transverse and conjugate diameters and v the miles traversed in a second, putting also b for the assumed *initial* distance upon the asymptote from the centre, so that $2\frac{b}{v}$ shall measure the time from the initial to the terminal places by the uniform and undisturbed initial motion, the nodal motion which applies individually to all the meteors of the *cylinder* will be expressed by $x\left(l.\frac{2b}{y}+l.\left[1+\left(1+\frac{y^2}{4b^2}\right)^{\frac{1}{2}}\right]-1\div\left(1+\frac{y^2}{4b^2}\right)^{\frac{1}{2}}\right)\frac{e}{v}$; in which x is constant, e is the earth's velocity, and $l.$ is the symbol for the Napierien logarithm; and which, when differentiated with reference to the spaces, gives

$$x\left(l.\frac{2b}{y}+4\frac{b^2}{y^2}\left[1-\left(1+\frac{y^2}{b^2}\right)^{\frac{1}{2}}\right]+l.\left[1+\left(1+\frac{y^2}{4b^2}\right)^{\frac{1}{2}}\right]\right)\frac{e}{v},$$

for the average of nodal effect upon the entire cylinder to the distance of $\frac{y}{2}$ on every side. The same is equivalent to a retrogradation of m, m, r, r (which are next the earth) to the distance of 1370 miles; while the advance $n\,q$ in the plane $\mathrm{E}\,s\,r$ is only 254 miles on the ecliptic *preceding* and 223 on the side *following*. Yet the advance is nearly constant, while the recession diminishes with the distance, and down to a very moderate average for the entire mass. If a factor is required for reducing the above uniform mean amount (239) to the average effect upon the whole cylinder whose radius of section is y, it may be obtained nearly by integrating the differential expression $\frac{a}{c^2}\overline{(1+c^2}.\overline{1-\cos.^2\mathrm{D})}^{\frac{1}{2}}d\cos.\mathrm{D}$; in which a is a constant derived from the inclination of the relative line and the amount of tangential perturbation, reduced to the plane of the ring, c is the natural tangent of that inclination, and D is the arc of the meteors' relative position in the normal cylindric section taken from the line of section of the latter with the ecliptic, so that this effect upon the nodal position, averaged for such a cylinder, will be comprehended with sufficient closeness in the expression $\frac{1}{2}\frac{a}{c^2}(1+c^2)^{\frac{1}{2}}$; also, $\frac{a}{c^2}(1+c^2)^{\frac{1}{2}}\sin.^2\mathrm{D}$ gives the same for any individual meteor. The factor therefore is the fraction $\frac{1}{2}$, neglecting a small term with a double sign which eliminates itself from the average by appearing in opposite senses on opposite sides of

the ecliptic. For the August meteors we thus perceive this average effect to be 120 miles advance, while the maximum in the relative plane is about 530 miles, and the corresponding retrogradation as above stated.

From these computations, as they now appear, the conclusion most pertinent to our object is that the nodes of the ring, so far as affected at all, are up to a certain limit retrogradient, and afterward advance, but only to an exceedingly minute angular amount in either case.

It farther deserves mention that there is due to the same acceleration on which the first of the above formulæ depends a motion in the radius vector itself,—the expression for which might readily be formed from the elements or quantities above employed, because it is one to which, within the limits of the problem, that retrograde nodal motion bears the same ratio that the tangential distance described by the earth in the time bears to the difference of the distances described parallel to the line of nodes St in the same time. (F)

The only question remaining of which it is proposed to treat, respects the cumulative effect, from year to year, which may be supposed to take place from disturbance by the earth,—confining attention, as was particularized at the outset, to the immediate actions, and *declining* for the present the larger question, but professing to attempt investigation relatively alone to *tendencies* which will take effect if no superimposed influences of planets or of the ring itself shall merge or counteract them.

If thus left free and undisturbed, the meteors would return to their nodes with the orbital conditions last impressed upon them by the earth. If then the meteoric orbits and the earth's were commensurable, the same conditions would be imparted at certain definite intervals to different groups or *cylinders*, as they have been termed above,—after which the concurrence with or penetration of the ring would be repeated in presence of the same bodies as at first, and the effects would be duplicated in a second *cycle* through the ring—then in a third, and so on. But the earth's disturbance would of itself prevent entire uniformity of orbital elements among the meteors. Even were it otherwise it could only be by the most improbable fortuity that the successive cycles, at least after several repetitions through the ring, could fail to present themselves successively a little in advance of or a little behind the individual penetrations of cycles which had preceded. In this manner, for a time, there would be an accumulation of effects through many cycles, continued until the individual penetrations instead of standing in the relation of being left more and more behind by the succeeding cycles should come more nearly into the condition of a successive approach by the same from an opposite direction. Under the ne-

cessarily resulting changes of presentation on one side of the earth and on the other, the effects which had accumulated for a time upon certain meteors would afterwards experience a gradual and successive compensation. In the absence therefore of superinduced disturbances it would appear that the ultimate constitution of the ring must be one in which accumulation and compensation will be going on equably and simultaneously, imposing a limit and maximum to the former. Nevertheless, up to such a limit, the accumulations do prevail. For in figure 1, let *p p* after having experienced, during a recession of cycles, an accumulation of effects on the side *following*, present itself, as it gradually must, farther and farther, within the spaces *preceding*, until it shall have come to the position *o o* where the supposed effects shall have received their compensation,—or vice versa, from *o o* to *p p*, if the cycles advance. The meteor is now in what may be considered its normal or neutral condition in respect to this class of effects; but between the two normal states at *p p* and *o o*, the accumulation with all its results will have subsisted in different degrees. In like manner an accumulation of opposite effects and results may then commence its progress and find a subsequent limit and compensation. It would be futile to pursue this view beyond a mere rudimental form so long as we cannot be certain that perturbations by other planets, and even by the ring itself, if it has mass enough, may not throw the meteors into quite other compensating positions than by the progress and succession traced above. Still, however promiscuous those positions, ordinary laws ensure constant although irregular *surges* of accumulated effects in various kinds, and opposite senses. The arbitrary supposition made in the outset, of orbits crossing in lines of mutual nodes or intersections normal to the ecliptic, however convenient in the first instance, is obviously not a necessary condition to the reception and accumulation of either class of effects which have entered into this discussion. It imposes no restriction upon our deductions. The one supposed line of mutual intersections would become progressively disposed into innumerable lines throughout the quadrants, in the manner explained above. If by original constitution the ring is supposed to embody within certain limits every variety and degree of orbital elements it is only what our preceding discussion has shown that the earth must itself produce. (G)

Our enquiry therefore—although by the very terms of its enunciation a partial one compared with the grand problem of the necessary ultimate constitution of the August meteoric ring—becomes the occasion of certain conclusions more or less definite, which it only remains to enumerate:—

1st. The position of the nodes cannot be shifted by the earth's action more than a degree or two in half a million of years. Without attempting nice determinations, in the absence of data entirely explicit, it is sufficient to observe that the few expressions above formed in (F) show such a balance of opposite effects as must leave the meteors which pass at three to five millions of miles on every side of the earth neutral in respect to advance or retrogradation,—so that a cylinder of many millions of miles diameter and length of axis, although retrograding in the parts within a certain limit as just mentioned and advancing in the parts beyond it, would as a mass remain not appreciably disturbed in either respect.

2d. An effect of another kind would however become appreciable in a separation into more or less advanced assemblages of orbits with constituent meteors retaining in various degrees a common amount or direction of disturbance. Thus a belt of orbits in planes parallel and contiguous to E*s t* will retrograde less than such as group themselves in planes parallel and near to the normal plane *u v* (see figure 2.) The latter will be occupied by meteors departing most from the mean longitude of the tangents and consequent radiant positions, while the former will exhibit the greatest variations of tangents, and of corresponding radiant positions, in their inclination to the ecliptic. Our results therefore do embrace a change of positions from day to day in determinate directions, *of the kind* shown upon the writer's fragmentary chart at p. 445 of the last November No. of this Journal,—not because of any direct action at or during the particular penetration in progress at the time, but because both the elevations and longitudes of that radiant are considerably and more or less *cumulatively* affected, and also the meteors similarly affected are congregated *in classes* into the more expanded or the less expanded orbits. The farther explanation, however, if not merging itself in a question of the particular primal constitution of the ring, properly belongs to the subject (not embraced in the preceding investigations) of the different nodal positions assumed in the lapse of ages by these two classes of orbits under the general planetary influences.

3d. There is an appreciable change of radiant positions relative to locality upon the earth's surface and to the hour of day, whose maximum is about $3\frac{3}{4}°$ between the extremes, and to which the extremes approach.

4th. The terrestrial disturbance is sufficient to affect the meteors' perihelion distances by many millions of miles and to expand the ring to a corresponding breadth at the ascending nodes; also to collect together in orbits of similar elements those meteors which are similarly affected in respect of radiant positions.

It ought not to be overlooked, in passing, that multitudes of the meteors appear to be thrown within the influence of the planet Venus by even a single conjunction of the earth with the ring. Under the effect of accumulation therefore, it is almost an unavoidable conclusion from the computations in (E) that the confines of the same ring which is intersected by the earth cross also the orbit of Venus, if not bodily, at least in the instance of multitudes of stragglers thrown tens of millions of miles away from their normal perihelion distances.

5th. The terrestrial disturbances do not appear sufficient to draw off meteors into permanently erratic orbits; so that, unless in exceptional instances, meteors are probably not lost to the ring other than those which the atmosphere absorbs or arrests. But if meteors can be arrested partially, and without being dissipated, in an excessively *tenuious* upper medium it becomes a plausible conjecture that the ordinary and unconformable meteoric wanderers may be such as have missed a return to the ring under the effect of atmospheric retardation.

If it be allowable to diversify topics which belong to the sphere of a rigid rationality by speculative fancies, or to attempt any addition to the interest which invests the bare existence of such a member of the cosmical system as a *meteoric ring*, I may add to the foregoing two other conjectural considerations or suggestions. It may be held as an interesting possibility—if no more—and as one which doubtless enhances the desirableness of fixing the exact elements of meteoric rings, that comets—whose vastly extended atmospheres or heads around the nucleus, although greatly attenuated, may be competent to arrest meteors completely—may be found, in rare instances, to have been disturbed by *impact* with a meteoric ring whose mere attractive influence it would not be possible to detect. Again, a far more interesting idea would be realized if analysis can but evince a necessary ultimate constitution existing in meteoric rings, and impressed upon them by the other members of the solar system in concurrence with their own mass; and of which the visible phenomena, as evidenced and defined by a comparison of numerous, long continued and varied observations, must have required not less than a certain definite cumulation of myriads of centuries for their production. Thus it is our fancy, and in a measure our hope, that the astronomer and analyst may discover in meteoric rings a kind of celestial monument whose hieroglyphics, deciphered and interpreted, shall date back the age of our solar system to at least a minimum period of duration in its present features and configuration.

Art. XXVII.—*Geographical Notices.* No. XVI.

The notices of the progress of Physical Geography which were commenced in this Journal in 1858, having been for a few months interrupted, it appears necessary in resuming them to refer briefly to certain expeditions of which our readers through other channels may have been already informed, but the effort will be made to report the latest information which has reached us from trustworthy sources.

Those who are interested in the maintenance of these Notices are respectfully requested to communicate to the undersigned or to the Editors of this Journal, such information of an original and reliable character as may come to their knowledge. Written communications and printed documents bearing in any way upon the progress of geographical science, (especially such as are not accessible through the ordinary channels of the book trade) are especially requested. As there is an evident propriety in making an American Journal the repository of everything which pertains to the exploration of this continent, all such information whether published by congressional or legislative bodies, by societies or by private enterprise will be particularly welcome.

Daniel C. Gilman.

Yale College Library, New Haven, February, 1862.

AFRICA.

Speke's Journey to Lake Nyanza.—Those who have kept informed in respect to the progress of African discovery will remember that on the celebrated journey (often referred to in this Journal) in which Major Burton visited and explored one of the great lakes of eastern central Africa, known as the "Tanganika," his associate, Capt. Speke, discovered at a considerable distance northeast and at a much higher altitude, a second immense lake called by the natives the Nyanza, to which the loyal Englishman prefixed the name of his sovereign, calling it the Victoria Nyanza. It is this second lake which was supposed to be the source of the Nile. In regard to it, however, nothing definite was known, as the explorer only saw the southern extremity and had only very meagre and indefinite information respecting its extent toward the north. The possibility and indeed the plausibility of the proposed solution of the vexed problem of the Nile induced the British Government to cöoperate with the Royal Geographical Society, in sending Capt. Speke to Zanzibar, once more, thence to retrace his steps to the Nyanza, and traverse the lake if possible to its northern shores, where of course it could be determined whether a great river flowed from

it. He set out upon this second journey April 21st, 1860, having as an associate Capt. Grant. They left Zanzibar for the interior Sept. 25, 1860. Letters have been received from them, dated Khoko in Western Ugogo, Dec. 12, 1860.

PETHERICK'S EXPEDITION TO GONDOKORO.—To cöoperate with Capt. Speke, Mr. John Petherick, (author of "Egypt, the Soudan and Central Africa; being Sketches from sixteen years travel," London, 1861, 8vo,) for many years British Consul at Khartum, has been commissioned by the Government and Society already mentioned, to go up the Nile to Gondokoro, fourteen hundred miles above Khartum and nineteen hundred above Alexandria, where he will be able to establish a depot of provisions and apparatus for Capt. Speke, and if need be, engage with him in exploring any part of that region. Gondokoro, described as being in north latitude 4° 30′ and east longitude 31° 50′, is the seat of an ivory mart during the months of December and January, when traders from Khartum visit it and obtain their ivory in exchange for grain and beads. Here also Knoblecher established a Roman Catholic mission which was abandoned in 1859.

The appeal of the Royal Geographical Society for funds to the extent of £2000, in aid of this expedition gives the following additional statements:

"Immediately above Gondokoro, a succession of rapids prevent farther navigation; below Gondokoro the passage is perfectly open to boats, sailing at the times when the periodical winds are favorable. During ten months of the year Gondokoro is deserted; the scanty and barbarous population of the village is dispersed over its barren neighborhood, and an expedition such as that under Captain Speke and Grant must necessarily be—exhausted of means of barter, and wholly ignorant of the negro languages of Northern Africa—will be sure to tempt hostility, and to incur serious danger of absolute want of supplies. If Captain Speke be unable to reach Gondokoro in December or January, his position will be exceedingly precarious, while farther advance to the north would be impossible.

"The first of Mr. Petherick's proposed objects, is to form a sufficient depôt of grain at Gondokoro, under the charge of his own men, to insure to Captain Speke means of subsistance and security from violence whenever he should reach that place; the second is, to explore the district colored *orange*, in the accompanying sketch map. The third is, to effect a meeting with Captain Speke, and to assist him through the hostile tribes between the Lake and the Nile. Many of these negro tribes are known to Mr. Petherick, and it is precisely in the locality where the party under Captain Speke would be most helpless, that that of Mr. Petherick would, comparatively speaking, be most at home; and even if the union of the two parties did not actually take place, the aid which Mr. Petherick's presence in the country might, with reason, be expected to afford to Captain Speke, can hardly be overrated.

"These circumstances being taken into account, together with the fact of Mr. Petherick's services being now available, who, beyond any other Englishman, is peculiarly fitted for carrying out the expedition he proposes, the President and Council of the Royal Geographical Society consider that they would fall short of their duty if they left any legitimate means unemployed for securing those services to the advancement of Geography and the honor of this country. Her Majesty's Government having declined to send out this additional expedition, the President and Council make their appeal to the liberality of individual Fellows of the Society and to that of the Public.

"The sum required to be raised is £2000. Should this be quickly obtained, Mr. Petherick will undertake to reach Gondokoro in November, 1861. He will then explore until March, 1862, when the setting in of the rainy season prevents farther movements. Starting afresh in August, 1862, he proposes to continue his travels till February, 1863, and after that to return to Gondokoro, reaching his depôt in 1863 or early in 1864."

Although only £1000, or half of the sum called for, was raised, Mr. Petherick set out in April, 1861. Letters have been received from him dated Korosko, Aug. 9, 1861.

The following instrumental instructions for his guidance were issued by the Honorary Secretary of the Society, F. Galton, Esq.:

"The observations that it is absolutely requisite you should make, are—

1. You are earnestly recommended to use every opportunity of practising with your sextants *upon stars* while on the lower Nile, and able to check your results with known latitudes; also to practise observing eclipses and occultations under the same circumstances.

"2. As a general rule, observations should be made at marked points, such as the confluence of rivers, prominent hills, and native towns, rather than at mere encampment.

"3. Reliable latitudes of different places on the White Nile between Khartum and Gondokoro, and on your further line of travel. The latitude of Gondokoro is especially desired, and the meridian altitudes of at least six stars; three north and three south should there be observed.

"4. Longitudes by the exceedingly simple methods of the eclipses of Jupiter's satellites, or of occultations of stars, to be made at Gondokoro and at the furthest point of your travel, or at places adjacent to these. The local time should there be determined by more than one set of observations, to guard against error, and the method of altitudes on both sides of the meridian should always be used. Any longitude south of the parallel of the Bahr el Ghazal would be very valuable.

"5. The elevation above the sea of the following places by observation of the temperature of boiling water:—Cairo; Thebes; Assoun; Junction of Atbara; Khartum; the capital of the Shilluk country; the river at a point opposite the Bahr el Ghazel; Gondokoro, and different stations on your further route.

"6. The three boiling-point thermometers to be occasionally compared, and to be carefully preserved, with the view of determining any changes in their index errors. They are also to be compared with those of Captain Speke, in the event of the hoped-for meeting taking place between you and that gentleman.

"7. Simultaneous observations of the rise and fall of the Nile, at Gondokoro and Khartum, should be instituted, and also at as many other places as trustworthy observers may be found to make them.

"8. It is of great geographical importance that the breadth, depth, and velocity of the Upper White Nile and its tributaries be ascertained, in order that their sections may be protracted, and the quantity of water that passes down them be determined. A few notes on practical methods of doing this will be prepared and given to you by Mr. George.

"9. The compass bearing of marked hills should be frequently taken, and the position whence they are observed defined and laid down as unmistakably as possible by cross bearing. Your course and estimated distances should be noted continuously day by day, and the variation of the compass frequently determined.

"10. Time observations with your chronometer should be taken whenever latitude observations are made. These will serve to connect distant points whose longitude has been reliably determined by the rare occurrence of satellite eclipses and occultations.

"11. If any architectural monuments are met with, it would be important to take sketches or photographs of them, however rude ; to make a general plan by measurement (for which a measuring-tape should be taken); and to note any peculiarities of construction or style, such as the use of the arch, the angles of the walls, doorways, and windows. If there be any inscriptions or hieroglyphs, they should be copied, or impressions taken of them, if possible, with coarse paper dampe l in water and pressed with a brush, upon the inscription. Any small objects of art or antiquity found amongst the natives should, if possible, be collected.

"12. Every observation is to be copied from your rough notes into the Register-book which is supplied to you. Your entries, up to the last opportunity of communicating this winter with Khartum, to be forwarded from Gondokoro to the Secretary of the Royal Geographical Society.

LATEST INTELLIGENCE FROM DR. LIVINGSTONE.—From the Proceedings of the Royal Geographical Society, London, it appears that Bishop Mackenzie, of the United University Central African Mission, arrived off the mouth of the Zambesi in February, 1861, where he found Dr. Livingstone and his associates about to start on an exploration of the Rufuma river, in hopes of discovering by its waters a more convenient access to the Nyassa and Shire districts. The Bishop and one of his companions joined the expedition.

A letter from Dr. Livingstone to the late Professor Ritter, dated from the Rufuma, March 2, was presented to the Berlin Geographical Society at its August meeting.

Subsequent intelligence shows that the attempt of this bold traveller to ascend the Rufuma in his new steamer, the *Pioneer*, was not successful. After grounding several times he had been obliged to desist, and return to the Zambesi. The failure was attributed to the fact that the boat drew five feet of water, and did not arrive from England till the rainy season was far advanced.

LEJEAN'S EXPEDITION TO GONDOKORO.—Mr. G. Lejean, who is said to have been aided in his outfit by the Emperor of the French, set out early in 1860 from Chartum, and went south, hoping to find the source of the White Nile in the Lake Nyanza of Speke,—the same end in part which Mr. Petherick proposed to himself. Lejean reached Gondokoro, and was then prevented by illness from pushing his explorations farther. But the Journal of the Geographical Society of Paris gives us reason to expect good results from his investigations in Eastern Soudan and high Nubia.

ROSCHER AND VON DER DECKEN.—Karl v. d. Decken, a friend of the late Dr. Roscher, (murdered in his attempt to reach Lake Nyassa from the East African coast,) endeavored to prosecute the discoveries of Roscher, but was robbed and driven back. A recent letter to Sir Roderick Murchison says that v. d. Decken will now try to reach the peaks of Kilimandjaro.

THE POLAR REGIONS.

THE POLAR EXPEDITION OF DR. HAYES.—The return of Dr. I. I. Hayes who set sail from Boston, July 10, 1860, for the purpose of adding to our knowledge of the Arctic Regions and especially of ascertaining whether there is an Open Polar Sea, has already been mentioned in this Journal, (xxxii, 452). Immediately after his arrival in Boston he addressed a letter to Henry Grinell, Esq., President of the American Geographical Society in New York, and on the 13th of November he made a public statement before the same society, under whose auspices in part he went forth, in respect to the results which his expedition accomplished. A few days later he addressed the Academy of Natural Sciences in Philadelphia upon the same subject. Full reports of these communications have been made in the newspapers of the day, but so far as we are aware Dr. Hayes has not yet printed any complete authentic account of his voyage. Indeed it is too soon to expect him to do so.*

In a letter addressed to Prof. B. Silliman, Jr., he speaks as follows in reference to one of these addresses: "You will understand that I do not undertake in it a discussion of results, for my materials are yet unreduced. I shall merely describe what I saw and what was done in behalf of the science of the Arctic regions. My materials are I believe of much value. Since the death of Mr. Sonntag I have labored almost alone and of course I have not done all that might have been accomplished by a *corps* of workers. The duties of my command occupied much of my time and I embraced every opportunity to collect photographic views. Of these I have nearly two hundred, many of them quite

* A phonographic report of the Philadelphia address (from the Phil. North American) will be found in Littell's Living Age, January 4, 1862.

good. My scientific friends will I trust therefore be lenient towards any imperfections or deficiencies in my results. The photographic views especially of the glaciers will not be without a certain scientific value.

The expedition has been for the most part fortunate and satisfactory."

Awaiting from Dr. Hayes a more elaborate statement of the voyage, we place upon record here for convenience of reference a few of the principal data.

The United States, Dr. I. I. Hayes, commander, set sail from Boston, July 10, 1860, and returned to that port, October 23, 1861. The first stopping place was Proven, in lat. 72°, then Upernavik, and then Tessuisak, in lat. 73° 40′ from which he set sail (going northward through Melville Bay) Aug. 22, 1860. After various repulses by the ice, the vessel entered Smith's Straits, Sept. 2. The ice was so extraordinarily thick that it prevented any access to the western coast of the straits, and Dr. Hayes contrary to his plan was driven into winter quarters on the east coast about ten miles north of Cape Alexander and about twenty miles south in latitude and ninety miles south by coast line of Dr. Kane's winter quarters in 1854–5. He named his harbor Port Foulke after a distinguished member of the Philadelphia Academy. The loss of Dr. Hayes's dog team, the death of his chief scientific reliance, Mr. Sonntag, the peculiar condition of the ice and other difficulties seriously interfered with the proposed sledge journey to the North,—but persevering, amidst great obstacles, Dr. Hayes succeeded in going as far north as 81° 35′ latitude which he attained on the 18th of May. He returned to his winter quarters in June. The remainder of the summer he spent in scientific researches and in making ready for his return voyage. He saw no reason to suppose that by spending a second winter in that high latitude he could with his reduced force accomplish enough to warrant the increased expenditure. The results of his voyage are thus briefly stated.

"1. A detailed survey of the west coast of North Baffin Bay, Smith Strait, Kennedy Channel, and the extension of the survey to the north of any previous explorations. This survey embraces about 1,300 miles of coast line.

"2. The discovery of a new channel opening westward from Smith Strait, parallel with Jones' and Lancaster Sounds.

"3. A detailed survey of the coasts of Whale Sound, and the coasts to the north and south of it. This survey embraces about six hundred miles of coast line.

"4. Surveys of glaciers by which their rate of movement is estimated.

"5. Complete sets of pendulum experiments.

"6. Sets of magnetic experiments at Port Foulke, Cape Isabella, in Whale Sound, at Upernavik and Godhavn.

"7. Topographic and hydrographic surveys, including tidal observations.

"8. Large collections of specimens of natural history, and geological and mineralogical collections.

"9. A continuous set of meteorological observations.

"10. An extensive collection of photographic views.

"11. The accomplishment of a more northern latitude than ever before attained upon land.

"12. Fresh confirmation of theories respecting the open Polar Sea."

TORRELL'S POLAR EXPEDITION.—The Swedish Polar Expedition under Torrell which was fitted out with extraordinary completeness has failed in its chief objects. The ships lay for more than a month in the Treurenberg Bay, on the north coast of Spitzenberg, shut in by pack ice, and were afterwards much hindered by bad weather and other difficulties, while the sled expedition to the North Pole was wholly given up on account of the floating ice.—*Petermann's Journal.*

THE NORTH ATLANTIC TELEGRAPH EXPLORATIONS.—Since the possibility of a transatlantic telegraph was so successfully demonstrated by Mr. Field and his associates in their great experiment of 1858, various plans have been suggested for accomplishing the same results in a manner more likely to be of lasting service. The scheme upon which most attention has been bestowed proposes to run a line from the North of Scotland to the Færoe Islands a distance of about two hundred and twenty-five miles; thence to Iceland about three hundred miles, thence to South Greenland about six hundred miles and thence to the coast of Labrador also about six hundred miles. The greatest of these intervals in which the telegraph wire would necessarily be submerged is less than a third of the distance between the points on the coasts of Ireland and Newfoundland which were successfully united in the experiment above referred to.

In one of the meetings of the Royal Geographical Society last year, this new project was discussed, and a great deal of fresh matter pertaining to the physical geography of the regions specified, was brought forward. Five papers were read. The first by Capt. McClintock, R. N., gave an account of his soundings on the *Bulldog* in the summer of 1860. The second by Sir C. T. Bright gave a report of the soundings of the *Fox* under command of Capt. Young. The third paper was a report of an exploration of the Færoes and Iceland by Dr. John Rae. The fourth paper was by J. W. Tayler, Esq., on the Fiords of South Greenland, and the fifth was by Col. T. P. Shaffner on Electric Circuits. These papers are printed in the Proceedings of the Royal Geographical Society, Vol. v, No. ii.

From the paper of Sir Leopold M'Clintock we make the following extracts in relation to the soundings which were made under his direction.

"Leaving the Færöe Isles on the 6th of July, we sounded across towards Ingolfsholde upon the southeast shore of Iceland, a distance of 280 miles, and found the depth to be generally less than 300 fathoms, the greatest depth being 680 fathoms. The specimens of the bottom consisted chiefly of fine sand, or mud and broken shells, and, in two instances, of minute volcanic debris; the temperature of the sea at 100 fathoms below the surface scarcely varied from 46°. The depth of water upon this section of the telegraph route is so moderate that it would be an easy matter to lay down a cable between Færöe and Iceland. Since my return I find that Beru Fiord, upon the east coast of Iceland, has been examined with a view to its selection as the landing-place for a cable; it is about 80 miles to the northeast of Ingolfsholde, and has the advantage of being somewhat nearer to Færöe."

* * * * "Five days of very calm weather enabled us to complete the line of soundings between Faxe bay [on the southwest coast of Iceland] and the southeast coast of Greenland. The depths generally were very regular, the greatest being 1572 fathoms, and situated in mid-channel; but when within 40 miles of Greenland the depth decreased from 806 fathoms to 228 fathoms, in the short distance of 3¼ geographical miles.

"The nature of the bottom was chiefly oaze, that is, fine mud partly consisting of minute organic remains; but near to Iceland volcanic mud and sand were more frequently brought up. The temperature of the sea at 100 fathoms below the surface gradually diminished from 46° near Iceland, to 39° off the Greenland coast. Circumstances which it is unnecessary to allude to here prevented me from commencing before 18th August the line of soundings between the southwest coast of Greenland and Hamilton Inlet on the Labrador coast, a distance of 550 miles.

"The Greenland shore was still blockaded by such a vast accumulation of drift-ice that we could not approach within 45 miles of it, at which distance the depth was ascertained to be 1175 fathoms. This line of soundings to Hamilton Inlet shows that the greatest depth—which is in mid-channel—is 2032 fathoms; and that the decrease is very gradual until within about 80 miles of Labrador, where there is a change from about 900 fathoms to 150 fathoms in 7 or 8 miles.

"The ocean-bed consisted of oaze, but with fewer microscopic organisms than previously met with, whilst the average temperature of the sea at 100 fathoms below the surface was 40°.

"Seven days were all I could devote to the examination of Hamilton Inlet. Its length was found to be 120 miles, whilst its width varies from about 15 miles at its mouth to scarcely half a mile at "the Narrows," which are about half-way up to its head, and above which it expands into an inland sea of about 20 miles in width. All this great inlet was rapidly explored, its main channel from "the Narrows" to seaward was sounded, and the whole laid down by Mr. Reed, master and assistant-surveyor, with sufficient accuracy for ordinary purposes; but these soundings are not nearly sufficient to meet the requirements of a cable-route, nor even to decide whether a cable should be landed there.

"We found the depths to be very irregular, and seldom sufficient to secure a submerged cable from disturbance by icebergs. A perfect survey is absolutely necessary, and may show that the shallow water and

reefs of rocks, which to our imperfect knowledge appeared intricate and unfavorable, may not only be avoided, but may afford a sure protection against the intrusion of icebergs within the mouth of the inlet. There are some small rocky islets off the mouth of this inlet, and of these Hern Islets lie nearly in the middle and contract the widest channel of entrance to about 5 miles; the greatest depth obtained in this channel was 49 fathoms. Had the depth of water amounted to 70 fathoms in as far as this position, I would not hesitate in pronouncing favorably of Hamilton Inlet as a terminus to the cable from Greenland."

The following profiles, copied from the London Mechanics Magazine, give an outline of the soundings referred to in these remarks. An official report of this survey has not reached us. A map in the Journal of the Geographical Society gives some of the soundings, but not in such a form as to make it easy for us to transfer them to our pages.

PROFILES OF THE DEEP SEAS.

DIAGRAM 1.

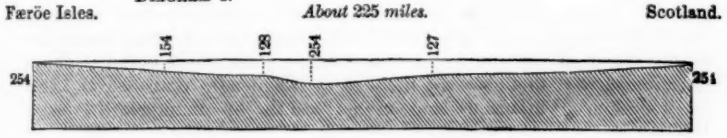


DIAGRAM 2.

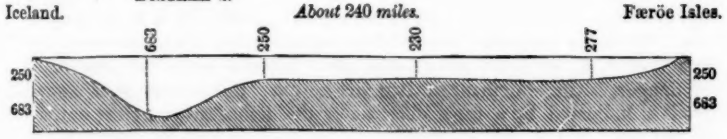


DIAGRAM 3.

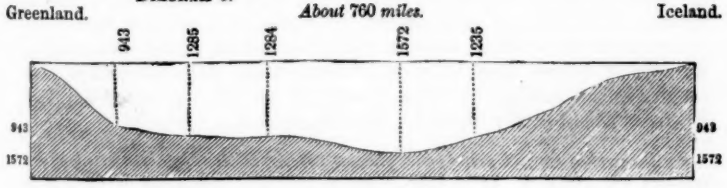
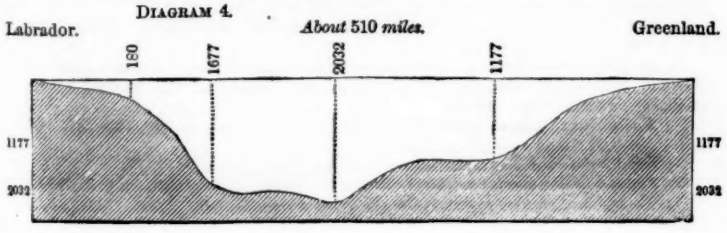


DIAGRAM 4.



SCIENTIFIC INTELLIGENCE.

I. PHYSICS AND CHEMISTRY.

Physics.

1. *Temperature of the Atlantic Ocean compared with that of the air from Southampton to Havana*, (In a letter from M. Andres Poey to Prof. Silliman, dated Havana, December, 1861.)—In my passage from Southampton to Havana from the 3d to the 22d of November last I undertook, at the suggestion of Mr. Charles Saint Claire Deville, for the benefit of science, to observe, at different hours of the day, the temperatures of the waters of the ocean and of the air, also the prevailing winds, the barometric pressure, the atmospheric electricity and polarization, the saltness of the sea, etc. Observations of this kind in the open sea are of great interest both to pure science and to navigation. It was by the collation of thousands of observations, made principally by American navigators, that Maury has reduced to fourteen days the voyage from any point of the United States to South America. It is also by the same method that Mr. C. Saint Claire Deville has pointed out the poles of heat and cold which eddy in the sea of the Antilles, where the curves are concentrically inflected.(1) At present I will simply call attention to the influence which shoals exert upon the thermic state of the ocean. These phenomena were first observed in 1776 by Blagden,(2) confirmed in 1789 by Jonathan Williams,(3) and more recently by Humboldt,(4) John Davy,(5) Peron,(6) and others.

The depression of temperature near the land reveals to the navigator the existence of a shoal, or the proximity of a coast which is yet invisible. Williams frequently observed a depression of temperature to the extent of 4° C. while he was at least three hours distant from any point of danger. The statement of Humboldt that "the proximity of a sand bank is indicated by a rapid decrease of the temperature at the surface of the sea" is not only interesting to the philosopher but important to the safety of navigation. The use of the thermometer should not of course lead to the neglect of the lead, but many experiments show that variations of temperature, measured even by imperfect instruments, give warning of danger long before the vessel comes upon soundings. In such cases the cooling of the water may lead the pilot to heave the lead where he would expect the most perfect security.(7)

(1) *Recherches sur les principaux phénomènes de Météorologie de la physique générale aux Antilles.* Paris, 1849, in 4to, p. 189–229. *Annuaire de la Société Meteorologique de France*, 1853, t. 1, p. 160–165, avec une carte.

(2) Volney: *Tableau du climat et du sol des Etats-Unis d'Amérique.* Paris, 1803, t. 1, p. 231.

(3) *Memoire sur l'emploie du Thermomètre dans la navégation.* Read in 1790 before the Philosophical Society of Philadelphia, and translated into Spanish by Vimercati. Madrid, 1794. 8vo.

(4) *Voyage aux regions équinoxiales.* Paris, 1816, en 8vo, p. 100, 129–131, 145, 151.

(5) Read before the Royal Society of London, May 13 and 22, 1817.

(6) *Voyages de découvertes aux terres australes.* Paris, 1816. 4to, t. 11, p. 324–347.

(7) *Voyage aux régions équinoxiales du Nouveau Continent.* Paris, 1816, t. 1, p. 100.

Mean daily observations made from the 3d to 22d Nov., 1861, *between Southampton and Havana, on board the steamship Atrato.*

Day of the month.	Temperature of the ocean.	Temperature of the air.	Height of Barometer.	Prevailing winds.
Nov. 3	13°·75 C.	12° C.	30·08 inches	W.S.W.
4	14 ·50	14	30·09	W.S.W.
5	15 ·75	15	30·05	W.S.W.
6	17 ·75	16 ·50	29·02	W.N W.
7	21 ·25	15 ·50	29·01	W.N.W.
8	18 ·50(8)	19 ·00	29·04	W.N.W.
9	22 ·25	20 ·75	29·08	S.E.
Rain. 10	22 ·50	21 ·00	29·06	W. by S.
11	22 ·75	21 ·25	29·04	W.S.W.
12	25 ·00	24 ·00	29·05	W.
13	25 ·25	24 ·25	30·07	S.W. by W.
14	26 ·75	25 ·00	30·08	W.S.W.
15	27 ·75	24 ·75(9)	30·02	S.
16	27 ·25	26 ·75	29·07	S.
17	27 ·00(10)	27 ·50	29·06	E.
18	27 ·25(11)	26 ·50	....	N.W.
19	27 ·00(12)	25 ·00	....	N.N.E.
20	27 ·50	26 ·75	....	N.N.W.
21	27 ·25(13)	26 ·00	....	N.N.W.
22	27 ·00(14)	26 ·50	....	E.S.E.
23	26 ·00(15)	27 ·00	....	E.S.E.

This table confirms the observations of Blagden and Williams. Thus the temperature of the water undergoes a remarkable depression on approaching shoals or land; as near the Azores, in the roads of St. Thomas, in the bay of Havana, and near the islands of Porto Rico, St. Domingo, and Cuba, also near Samana, Cape Grange, fort Moro, Matanzas and Havana.

2. *Dove's Photometer.**—The new photometric method proposed by Dove, has the advantage over those now in use, that it is equally applicable to the determination of the intensity of the light proceeding from a bright or faintly luminous body, whether it be white or colored, transparent or opaque; it is suitable also to determine the amount of light transmitted by optical instruments. The apparatus used is the compound microscope, which is usually brought into a horizontal position: a minute photograph representing black letters on a white (transparent) ground, or simply a cross on a similar ground, is placed on the stage and viewed under a power of from 20 to 60 diameters. The letters will of

(8) In sight of the Azores, distant 4 kilometres (= 2½ miles).
(9) Sky overcast.
(10) In the roads of St. Thomas.
(11) In view of Samana.
(12) In view of Cape Grange (Mount Christi of St. Domingo).
(13) In view of fort Moro, Cuba.
(14) In view of Matanzas.
(15) In the bay of Havana.

* Pogg. Annalen, vol. cxiv, No. 9, p. 145.

course appear by transmitted light, black on a white ground, and white on a black ground by reflected light, while the two illuminations can readily be balanced so that the letters are made to disappear. This is perhaps most elegantly effected by the use of two Nicol's prisms, one placed under the stage, the other directly behind the objective or eyepiece. By the revolution of either prism the transmitted light is weakened till the compensation is exactly effected, and the letters made invisible. The compensation may also be effected by reducing the size of the aperture under the stage, or by varying the distance of the luminous body which stands in the axis of the microscope. The light furnished by two candles is compared by placing them one at a time in the prolongation of the axis of the compound body, and varying their distance from the microscope till the compensation has been made for each separately. Their distances from the microscope is measured and furnish the data for calculating the relative amounts of light emitted, the zero of the scale being the microscopic photograph. The intensity of the light in various parts of the spectrum is measured by allowing different portions of it to fall on the under side of the photograph and effecting compensation. Nothing can be simpler than the application of this method to the determination of the equality, or inequality, in the amount of light transmitted by, or reflected from, differently colored substances. Dove recommends that photographs should be especially executed for this photometer, and I have found in fact that some are more delicate in their indications than others; the letters or figure ought to be very sharp at the edges, for if they are surrounded by an outline differing a little in density from the central portions, this in practice becomes a dividing band between the two shades and renders compensation difficult. It would also be well to remove the iodid of silver by cyanid of potassium, instead of the hydrosulphite of soda, as the letters then appear considerably brighter by reflected light. It is desirable that the sensibility of this new method, as compared with others now in use, should be tested by a carefully made series of numerical determinations.

O. N. R.

3. *On the specific heat of certain elements.*—Regnault has determined the specific heat of one or two elements not previously examined, and has revised that of others which were somewhat uncertain, in consequence of the impurity of the specimens which he employed in his earlier researches. The results are most conveniently exhibited in a tabular form.

	Spec. heat.	Atomic heat.	Equivalent. O=100.
Magnesium,	0·2499	37·49	150
Lithium,	0·9408	75·61	80·37
Osmium,	0·03113	38·11	1244·2
Rhodium,	0·05803	37·84	652·1
Iridium,	0·03259	40·19	1233·2
Manganese,	0·1217	39·55	325·0
Nickel,	0·1108	38·78	350·0
Cobalt,	0·10620	37·17	350·0
Tungsten,	0·3342	38·43	1150·0

	Spec. heat.	Atomic heat.	Equivalent.
Silicon (cryst.),	0·1774	46·92	266·7
Silicon (fused),	0·1750	31·29	177·8
		15·64	88·9
Boron (amorphous),	0·4053		
	0·3483		
	0·3598		
Boron (graphitoid),	0·2352		
Boron (cryst.),	0·2622		
	0·2253	34·1	136
	0·2574		

From the above table it will be remarked that all the elements examined obey the law of Dulong except lithium and silicon. Regnault repeats in connection with lithium a suggestion long since thrown out by him, that the true equivalent of lithium is 40·18, and that consequently lithia should be written L_2O, just as for similar reasons potash and soda should be written K_2O and Na_2O. In the case of silicon the author remarks that no one of the three equivalents which have been proposed for this element corresponds to the law of Dulong, but that if we adopt for silica the formula Si_2O_5, which requires the equivalent 222·3, the atomic heat becomes 39·12, and comes within the ordinary limits of experimental error. Regnault does not adopt this view, but simply calls attention to the subject. It is possible, certainly, that silicon exhibits the same anomalies in its different forms as carbon. The specific heat of boron is doubtless somewhat too low, and the different experiments do not agree well with each other.—*Ann. de Chimie et de Physique*, lxiii, 1.

W. G.

CHEMISTRY.

4. *On the Cyanid of Sulphur.*—LINNEMANN has succeeded in preparing a cyanid of sulphur by the action of iodid of silver upon sulphocyanid of silver, iodid of silver and cyanid of sulphur being the only products of the reaction. The cyanid of sulphur, $\left.\begin{matrix}S\\S\end{matrix}\right\}Cy_2$ or S_2Cy_2, presents colorless rhombic tables, or long thin leaves which have an odor analogous to that of iodid of cyanogen, and evaporate slowly but completely in the air. Between 30° and 40° it sublimes and condenses in small thin leaves; at 60° it melts to a clear and colorless liquid, which on cooling solidifies to a white crystalline mass. When heated in a flame, it burns with the color of cyanogen. The cyanid is soluble in ether, alcohol and water, and crystallizes easily on cooling. Strong sulphuric acid dissolves it in the cold without decomposition, which however takes place on diluting the solution with water. Nitric and chlorhydric acids decompose it easily in the cold. Potassium attacks it strongly, cyanid and sulphocyanate of potassium being the products of the reaction. An alcoholic solution of potash produces with it, cyanate and sulphocyanate of potassium, the reaction being represented by the equation

$$\left.\begin{matrix}Cy\\Cy\end{matrix}\right\}S_2+\left.\begin{matrix}K\\K\end{matrix}\right\}O_2=\left.\begin{matrix}Cy\\K\end{matrix}\right\}O_2+\left.\begin{matrix}Cy\\K\end{matrix}\right\}S_2.$$

The action of sulphydric acid, sulphid of potassium and nascent hy-

drogen upon cyanid of sulphur is represented by the three following equations.

(1.) $Cy_2S_2+H_2Cy=H \quad +CyH, S_2$

(2.) $Cy_2S_2+H_2S_2=CyH+CyH, S_2+S_2$

(3.) $Cy_2S_2+K_2S_2=CyH+CyK, S_2+S_2$

A molecule of cyanid of sulphur unites directly with two molecules of ammonia to form an ammonium-sulphid which has the formula $\left.\begin{matrix}NH_3Cy\\NH_3Cy\end{matrix}\right\}S_2$.

This sulphid is a crystalline powder insoluble in ether, and easily prepared by passing dry ammonia into an etherial solution of the cyanid of sulphur. The author endeavored to obtain a bisulphid of cyanogen, by the action of an etherial solution of iodine upon sulphocyanid of silver. Iodid of silver is formed and a peculiar reddish brown very volatile liquid, which was not further investigated but which can scarcely be anything else than $\left.\begin{matrix}Cy\\I\end{matrix}\right\}S_2$. The cyanid of selenium so closely resembles the cyanid of sulphur in all its properties that the two bodies might easily be confounded; it is obtained by an exactly similar reaction.—*Ann. der Chemie und Pharmacie*, cxx, 36. W. G.

5. *On a combination of hydrogen and iron.*—Wanklyn and Carius have studied the action of zincethyl upon the chlorids and iodids of silver, copper, iron and nickel. The reactions represented by the equations

(1.) $(MeCl)_2+Zn_2(C_4H_5)_2=Zn_2Cl_2+Me_2+(C_4H_5)_2$

(2.) $(MeCl)_2+Zn_2(C_4H_5)_2=Zn_2Cl_2+Me_2+C_4H_4+C_4H_6$

take place with subiodid of copper or with chlorid of copper and chlorid of silver. The action of zincethyl upon iodid of iron and probably also on chlorid of nickel takes place according to the equation

(3.) $(MeCl)_2+Zn_2(C_4H_5)_2=Zn_2Cl_2+(MeH)_2+(C_4H_4)_2$.

When zincethyl diluted with an equal volume of ether is brought in contact with iodid of iron, an evolution of gas immediately ensues, and when the action is over, a black powder remains, which is to be completely washed with pure ether. The powder gives off hydrogen by gentle heating, but at ordinary temperatures and with exclusion of water, may be preserved unchanged. When distilled water is brought in contact with the powder, pure hydrogen is given off, which does not occur with iron reduced by hydrogen. From this it appears that the powder is a combination of iron with hydrogen, which in contact with water gives protoxyd of iron and free hydrogen; the formation of protoxyd of iron is shown by the fact that the residue of the treatment with water, dissolves in dilute chlorhydric acid to protochlorid of iron almost without evolution of gas.

The composition of the hydruret of iron appears to be represented by the formula Fe_2H_2, though it is difficult to obtain the substance free from metallic iron. The authors suggest that the compound is well adapted to the replacement of chlorine or oxygen by hydrogen, and are engaged with further investigations of the subject.—*Ann. der Chem. und Pharm.*, cxx, 69. W. G.

6. *Lithia in Meteorites.*—BUNSEN has examined with the spectroscope two meteorites, that of Juvenas in France, which fell on the 15th of May, 1821, and that of Parnallee in South Hindostan, which fell on the 28th of February, 1857. He found in these however only the usual earthy elements, and in addition lithia, which has not hitherto been observed in meteorites.—*Ann. der Chem. und Pharm.*, cxx, 253. W. G.

7. *On the determination of Carbon in Iron.*—WEYL has given an ingenious and simple method of determining the quantity of carbon in cast-iron and steel without the previous difficult and laborious pulverization of the metal. The method consists in making the iron to be analyzed the positive electrode in dilute chlorhydric acid, when the iron dissolves, leaving the carbon, and without evolution of gas. To prevent the iron from becoming passive, which would produce an evolution of chlorine, it is only necessary to regulate the strength of the current by adjusting the distance of the electrodes from each other, so that only protochlorid of iron is formed; the formation of the sesquichlorid is indicated by the yellow color of the solution. A single Bunsen's element is sufficient, and the iron dissolves as protochlorid, leaving the carbon as a pseudomorph. The iron to be dissolved may be held in a forceps provided with platinum points, but so that the points of contact between the platinum and the iron cannot be moistened by the liquid. The separated carbon is to be collected upon an asbestos filter, dried in a current of air, and burned with oxyd of copper and oxygen in the usual manner. The weight of the iron dissolved is easily found by weighing the portion which remains between the platinum points and the surface of the acid, after the complete solution of the immersed portion. A number of analyses conducted according to this method gave results which closely corresponded and which were usually a little higher than those obtained by the ordinary methods. With respect to the time required, the author remarks that a piece of cast-iron weighing about eight grammes, is dissolved in twenty-four hours.—*Pogg. Ann.*, cxiv, 507. W. G.

8. *On the peroxyds of Potassium and Sodium.*—HARCOURT has studied the action of dry air and oxygen upon metallic potassium and sodium. The action of dry air upon potassium appears to consist of at least two stages. By carefully regulating the heat and the supply of air, nearly the whole of the potassium may be converted into a white oxyd. The exact amount of oxygen absorbed in this case is difficult to determine, as the oxydation rapidly proceeds farther, but the white oxyd appears to be a binoxyd. As the oxydation increases, the color becomes yellow, and by finally employing pure oxygen gas, a chrome yellow powder is obtained. The author represents the constitution of this body by the formula K_2O_8, though we are unable to see why the formula should not be KO_4. Water decomposes the powder with effervescence and formation of the binoxyd, the equation being

$$K_2O_8 = K_2O_4 + O_4.$$

The peroxyd of sodium as prepared by a similar process is of a pure white color; like the oxyds of zinc and tin, it becomes yellow when heated, and on cooling again loses this tint. Great heat is produced on mixing it with water, and a small quantity of gas is evolved; its constitution

is represented by the formula Na_2O_4 or NaO_2. The binoxyd of sodium is soluble in water, and the solution on evaporation gives large tabular crystals of a hydrate, which has the formula Na_2O_4+16HO. Another hydrate produced by the efflorescence of the first, has the formula Na_2O_4+4HO.—*Quar. Journ. of Chem. Soc.*, Oct. 1861, p. 267. W. G.

9. *On the constitution of Croconic and Rhodizonic Acids.*—Will finds the formula of crystallized croconic acid to be $C_{10}H_2O_{10}+6HO$, according to which the acid is bibasic. The formulas of some of its principal salts are as follows:

2. $C_{10}Ba_2O_{10}+6HO$. $C_{10}Ca_2O_{10}+6HO$. $C_{10}Pb_2O_{10}+4HO$. $C_{10}Aq_2O_{10}$.

The yellow solution of croconate of potash is easily decolorized by oxydizing agents. Nitric acid and chlorine give rise to a new acid, which the author terms leuconic acid, the empirical formula of which is $C_{10}H_8O_{18}$, the rational formula being probably $\left.\begin{matrix}C_{10}H_5O_{12}\\H_3\end{matrix}\right\}O_6$, so that the acid is tribasic.

Rhodizonic acid has most probably the formula $C_{10}H_4O_{12}$, and is tribasic. Its principal salts have, according to Will, the formulas:

$C_{10}H_2K_2O_{12}+2HO$, $C_{10}H_2Ba_2O_{12}+2HO$, $C_{10}HPb_3O_{12}$, $C_{10}HAg_3O_6$.(?)

The rhodizonic acid obtained by Brodie, by the action of absolute alcohol on the compound of carbonic oxyd and potassium, has probably the formula $C_{20}O_{16}K_6$ or $C_{10}O_8K_3$, and by solution in water, taking up oxygen and giving off potash, is converted into croconate of potash. The acid of Will is clearly different, and dissolves in water without an alkaline reaction.—*Ann. der Chem. und Pharm.*, cxviii, 177, 187. W. G.

10. *On the presence of Rubidium and Cæsium in Triphyline;* by Eli W. Blake, Jr., of New Haven.*—Having obtained a quantity of the residues of the preparation of lithia from triphyline, which gave, when examined in the spectrum apparatus evidences of the presence of rubidium and cæsium, I have at the request of Prof. Bunsen made an analysis of it. After the removal of the iron and phosphoric acid, and the conversion of the sulphates of the alkalies into chlorids, it was found to contain:

Chlorid of lithium,	40·98
" " potassium,	9·29
" " sodium,	50·04
" " cæsium,	0·11
" " rubidium,	0·18
	100·60

The method of estimating the rubidium and cæsium depends upon the insolubility of their platino-chlorids as compared to that of the same salt of potassium, and the difference of solubility is not so great as to give very accurate analytical results. The above approximation however serves to show, that like some other minerals containing lithia, triphyline contains small quantities of these new and highly interesting alkaline bases.

* In a letter to G. J. Brush, dated Heidelberg, Jan. 12th, 1862.

TECHNICAL CHEMISTRY.—

11. *On a Safety-lamp for laboratory use;* by C. M. WARREN.—The danger attending the distillation of highly inflammable liquids, in glass retorts, over an open flame,—and other manipulations of similar nature,—as commonly practiced in laboratories, has probably been felt by every one who has made such experiments. By the exercise of due precaution, the chances for accident under such circumstances, may doubtless be greatly reduced; yet the consequences which may result from a single mishap, are liable to be so serious (as the fate of the lamented Mansfield gives painful evidence, although I believe he was using a metallic retort at the time of the fatal occurrence), that it seemed to me desirable to devise means by which such experiments may be conducted with safety; especially as the chemist has so frequently to resort to protracted fractional distillation of complex mixtures of inflammable substances, as his only means by which to effect a separation.

I find that a lamp may be constructed on the principle of Davy's safety-lamp for miners, so as to afford the important desideratum of safety, and at the same time combine utility and convenience for general use, in cases where a broad open flame and a diffused heat are desirable. Simple modes of applying the principle will readily suggest themselves.

It is only requisite that the flame should be properly enclosed, and so placed and adjusted in relation to other parts of the lamp, that no part can become excessively heated, and yet so as to afford sufficient heat for any work of the kind that may be presented,—the openings below and above for the supply of air and escape of the products of combustion, being securely covered with fine wire gauze, of about 2500 meshes to the square inch. With certain slight alterations, the lamp figured under "Gaskochlampen" in J. F. Luhme & Co.'s, Berlin, catalogue of chemical apparatus—a medium size of which is represented in the annexed figure—makes a cheap and convenient lamp of this kind. As they may not be on sale in this country, a partial description, for the convenience of those who may desire to have them made, may not be amiss.

The sides are of a single piece of sheet iron, riveted together where the ends meet; the upper and lower edges are bent respectively upward and downward so as to stand in a good position to receive the movable brass rings, *a a*, which serve to hold firmly the wire gauze with which the top and the bottom of the lamp are covered.

As the wire gauze will occasionally require to be renewed, this simple mode of construction seems a very convenient one, as the movable rings may readily be taken off and replaced whenever new gauze is needed.

The tubulure, *b*,—which may be closed with a cork—serves for the introduction of a match for lighting. The nipple, *c*, communicates in the interior with a ring, 2½ inches in diameter, made of copper tube, and placed in the centre of the lamp, 3½ inches below the upper gauze, and provided

with small perforations in the upper side, for escape of the gas. The height of the lamp, between the upper and lower sheets of gauze, is 5½ inches; its width across the top 4 inches, and across the bottom 6 inches.

The only alterations which I have made, consist in the addition of the tubulure, *b*, and the wire gauze across the bottom. It is obvious that they do not at all interfere with the use of the lamp as originally intended. It may still be ignited outside the gauze, so as to give a broad, open, blue flame. When used as a safety-lamp it is, of course, to be lighted inside, and furnishes a circuit of small luminous flames, but which afford sufficient heat for any purpose for which a safety-lamp is conceived to be desirable.

To show the confidence which one may repose in the safety of such a lamp, I may add that, I have repeatedly tested one by heating a fatty oil to ebullition—during which the gauze immediately under the retort would acquire a dull red heat—and then pouring boiling ether upon the different parts of the lamp, without, in a single instance, being able to ignite it outside the gauze. A portion of the ether would fall through and burn in the interior, while some would lie in the spheroidal state upon the gauze itself, until evaporated: showing that, if one were distilling such a substance, even with such an excessive heat in the lamp, the retort might break, and its contents fall through upon the lamp without any kind of danger. A similar safety-lamp could easily be constructed for using alcohol instead of gas.

Boston, February, 1862.

12. *Description of a new Fusible Alloy;* by B. Wood, M.D.—In this Journal for Sept., 1860, will be found a notice of the cadmium alloy discovered by me consisting of from one to two parts of cadmium, two parts of tin, four parts of lead, and from seven to eight parts of bismuth, and so exceedingly fusible as to melt below the temperature of 160° Fahr. A brief description of another alloy similar in character and scarcely less remarkable, is herewith submitted. It consists of,

Cadmium 1 part, lead six parts, bismuth 7 parts.

This alloy melts at about 180° Fahr., being nearly midway between the melting point of the old fusible metal consisting of the *three* metals, tin, lead, and bismuth, and that of the alloy first mentioned consisting of the *four* metals, cadmium, tin, lead, and bismuth. It is remarkable as exhibiting the liquidifying property of cadmium in certain combinations; also in the fact that while the mean melting point of the constituents composing it is much higher than that of those composing the old fusible metal, it melts at a much lower temperature,—being more fusible than any other *alloy* yet known consisting of but *three* metals.

It has a clear, brilliant metallic lustre that does not readily tarnish. Its color is a bright bluish gray, resembling platinum: when cast, its free surface presents a white, frosted appearance. It is very flexible in thin plates, and breaks with a hackly fracture; but when thicker bars are broken, the fracture is smooth, resembling that of tempered steel. It is malleable but not perfectly so. In hardness it is about the same as bismuth, and about the same as an alloy of two parts of lead and one part of tin, or "coarse solder" which it resembles more nearly in other respects.

It may be that more approved methods of measuring temperature will

give the alloy a still lower melting point than above ascribed to it, as I see that the experiments made by Lipowitz* with my "fusible metal" indicate for it a much greater fusibility than my measurements.

Indianapolis, Ind., Dec. 21, 1861.

13. *Preparation of Hydrofluosilicic acid.*—H. DEVILLE prepares hydrofluosilicic acid by causing water to fall, drop by drop, upon a mixture of fragments of stone-ware and fluor-spar heated to redness in a tubulated earthen retort, or, somewhat less conveniently, by passing a current of steam through the mixture. By condensing the vapors formed, liquid hydrofluosilicic acid of about 17° B. is obtained, and this by concentration may be brought to 29° and 30° without depositing any silica, while the acid prepared in the ordinary way by dissolving fluorid of silicon in water can be brought to a strength of only about 4° and 5° before the solution becomes solid from the separation of gelatinous silica. At 7° B. a solution of hydrofluosilicic acid contains 66 grms. of the anhydrous acid ($2SiFl_3$, $3HFl$) per litre. At 29°, the maximum condensation, it contains 325 grms. per litre.

The acid of 29° is very energetic, expelling almost all the acids, excepting sulphuric acid, when heated with their compounds. Since it does not attack wood or other organic matters it may be kept in kegs. It has but little action upon vessels of stone-ware, but destroys glass somewhat rapidly with formation of fluosilicate of soda. In the opinion of the author this acid is destined to become of considerable industrial importance.—*Annales de Chim. et Phys.*, lxi, 333. F. H. S.

II. GEOLOGY.

1. *Note on the occurrence of Glauconite in the Lower Silurian Rocks;* by T. STERRY HUNT, M.A., F.R.S., of the Geological Survey of Canada.—In this Journal for Sept. 1858, xxvii, 238, I mentioned that glauconite appears to be the coloring matter of some Silurian sandstones; and in the Report of the Geological Survey for 1859, p. 195, I gave analyses of this material from the rocks of the Quebec group at Point Levis and the island of Orleans. In the latter place there are layers in the dolomitic conglomerate, which contain more than half their weight of soft rounded bright green grains closely resembling the green sand of the Cretaceous period. Analysis shows them to be a hydrous silicate of alumina and protoxyd of iron with about eight per cent of potash, differing from the glauconite of secondary rocks in containing a large proportion of alumina. I have since observed a similar mineral in limestones of the age of the Quebec Group from Texas, and in the Potsdam sandstone of the Uppper Mississippi where bright green layers described by Prof. Owen contain a large proportion of glauconite, whose composition approaches still closer to that of the secondary rocks. I am indebted for specimens of this to Prof. James Hall.

Murchison notices layers of green sand at the base of the Pleta limestone in Russia—and in Esthonia and Livonia, according to Schmidt, it characterizes strata which immediately overlie the alum slates.

The occurrence of these green grains in strata near the base of the Pa-

* Dingler's Polytechnisches Journal, clviii, 376, Lipowitz found that "Wood's fusible metal" when made of 8 parts of lead, 15 parts bismuth, 4 parts tin and 3 parts cadmium, fused at 60° C. (140° F.).—EDS.

læozoic series in regions so remote as Texas, the Upper Mississippi, the Lower St. Lawrence and the shores of the Baltic, is a fact worthy of further attention, and I shall send you my detailed analyses at an early day.

Montreal, Feb. 1st, 1862.

2. *On the Saurian Vertebræ from Nova Scotia.* In a letter from Mr. O. C. MARSH to Prof. B. SILLIMAN, Jr.—[In publishing Prof. Agassiz's letter on page 138 of this volume, we supposed the vertebræ were newly found; this is a mistake, we saw these vertebræ in Mr. Marsh's hands six years ago when they were first discovered, and we assumed that the bones referred to by Prof. Agassiz were the results of last summer's explorations. The following note from Mr. Marsh sets the matter right.—S.]

"The Saurian vertebræ from the Joggins coal formation of Nova Scotia, alluded to in Prof. Agassiz's letter in your January number, were not discovered last summer as the notice stated, but in August, 1855, while I was examining that locality in company with Mr. W. E. Park of Andover, Mass. In the hope of obtaining further remains I have hitherto deferred publishing any account of these remarkable fossils. A recent re-examination of the locality, however, afforded nothing of a similar nature, and I see no reason for longer delay in announcing the discovery.

"The vertebræ were imbedded in a stratum of shale which forms part of group XXVI in the section made of this formation in 1852 by Sir Charles Lyell and Prof. J. W. Dawson. The coal measures at this place have a vertical thickness of about 14,570 feet, and the stratum which contained the remains is a little more than 10,000 feet above their lower limits. It is beneath nearly 5000 feet of coal strata containing about twenty separate veins of coal.

"The vertebræ are about two and a half inches in transverse diameter, flattened and deeply biconcave. They resemble in form the vertebræ of an Ichthyosaurus, and at the time of the discovery I referred them to that genus. A subsequent comparison showed some points of difference, but the Enaliosaurian characters appeared to be equally marked in each.

"As these remains are apparently distinct from any known genus, I would propose for the species the name *Eosaurus Acadianus.* A description of the vertebræ, with plates, will appear in the next number of the Journal of Science. Very truly yours, O. C. MARSH.

"Yale College, Feb. 10th, 1862."

3. *Canadian Pleistocene Fossils and Climate.*—Prof. Dawson, in a paper published in the Canadian Naturalist, gives a more complete list of the fossils of the drift in Maine, Canada, Labrador, &c., than has been before presented, and makes some interesting deductions from them in regard to the physical geography, climate, &c. of that part of the North American continent during that period.

From the facts now given, and others before reported, the conclusion is unavoidable that a far greater degree of cold prevailed during the pleistocene epoch than at present. The causes of this difference of climate Prof. Dawson finds in great recorded changes of level, and in the different distribution of land and water; during the cold period—as he infers—the relative proportion of dry land surface in the arctic regions to that in the temperate zone having been considerably greater than now. N.

4. *The Pre-Carboniferous Flora of New Brunswick, Maine and Eastern Canada;* by Prof. J. W. DAWSON, LL.D. &c., (Canadian Naturalist, May 1861.)—In this and a former paper Prof. D. describes a large number of

Devonian fossil plants all new to science except one Calamite, (*C. transitiones*) found in Europe. These plants were collected at Gaspé, C. E., St. John's N. B., and Perry, Maine, and represent the following genera, *Prototaxites* 1 sp., *Dadoxylon* 1, *Sternbergia* 1, *Aploxylon* 1, *Sigillaria* 1, *Calamites* 1, *Arterophyllytes* 1, *Sphenophyllum* 1, *Lepidodendron* 1, *Lepidostrobus* 2, *Lycopodites* 1, *Psilophyton* 2, *Selaginites* 1, *Megaphyton?* 1, *Cordaites* 2, *Sagenaria?* 1, *Cyclopteris* 1, *Sphenopteris.*

Of these the *Cyclopteris* (*C. Jacksoni*) is the same submitted by Prof. Rogers to the geological section of the American Association at Newport, R. I. By him, as by Prof. Dawson, it was compared with *C. Hibernica* of Ireland. This and other species afford an interesting parallelism with the Devonian Flora of Europe.

In a note to Prof. D.'s paper, reference is made to the discovery by Mr. Hartt of a number of additional species at St. Johns, N. B. Of these, specimens have been sent to the Geological Cabinet of Yale College with some of the plants described by Prof. Dawson; they include several new ones and some genera not contained in Prof. D.'s catalogue. There are among them *Neuropteris, Sphenopteris, Nöggerathia, Cyclopteris, Cordaites* Unger, (properly *Pycnophyllum* Brong., as Unger's genus was published in 1850, Brongniart's in 1849,) *Lepidodendron, Annularia*, etc.—all closely allied to carboniferous species, but apparently distinct.

Goeppert in his recent memoir enumerates 57 species of Devonian plants of which he regards 50 as terrestrial—combining the plants formerly described from the Devonian rocks of Pennsylvania and New York, with those now referred to, the number of species of this date now known in America will be seen to be nearly or quite equal to that of Europe. As the subject of our Devonian flora has but just attracted the attention of fossil botanists, we may expect that future discoveries will prove it to be much more rich in species than has been supposed.

So far as the materials now in our possession suffice for a comparison between the Devonian plants of Europe and America, they would seem to indicate with equal *generic* identity a greater *specific* difference than has been noticed in the flora of the Carboniferous period. N.

5. *New species of Lower Silurian fossils;* by E. Billings, F.R.S., Palæontologist G. S. C. Montreal, 21st January, 1862. This is a continuation of a paper published Nov. 21st, 1861, and noticed on page 136 of the January number of this Journal. It is issued by the Geological Survey of Canada—under the able management of the distinguished geologist Sir W. E. Logan, F.R.S.—and contains well written descriptions, and excellent wood cuts of about fifty new species, and one new genus of Lower Silurian fossils. These fossils are from the Calciferous, Chazy, Black-river, and Trenton formations, and belong to the following genera, viz:—*Lituites* 2 species, *Nautilus* 1 sp., *Orthoceras* 2 sp., *Holopea* 4 sp., *Cyclonem* 2 sp., *Pleurotomaria* 2 sp., *Murchisonia* 4 sp., *Eunema* 2 sp., *Subulites* 1 sp., *Metaptoma* 6 sp., *Avicula* 1 sp., *Conocardium* 1 sp., *Modiolopsis* 5 sp., *Ctenodonta* 1 sp., *Cyrtodonta* 1 sp., *Lingula* 6 sp., *Discina* 2 sp., *Trematis* 3 sp., *Arthroclema* (new genus) 1 sp., *Stromatopora* 1 sp., *Serpulites*, species, and *Bathyurus* 1 species.

6. *Fourteenth Annual Report of Regents of the University of New York, on the condition of the State Cabinet of Natural History, and the Historical and Antiquarian Collection annexed thereto,* made to the As-

sembly, April, 1861. Albany, Aug. 1861.—This brochure consists of the usual report of the Chancellor, giving a statement of the condition of the State Cabinet of Natural History, and of the expenditures during the year for the purpose of increasing its extent and usefulness; together with the following appendices:—

"(A.) Catalogue of the additions made to the State Cabinet of Natural History, from January 1st, 1860, to January 1st, 1861."

"(B.) Guide to the Geology of New York, and to the State Geological Cabinet,—prepared by direction of the Regents; by Ledyard Lincklaen, Esq." This is an interesting and instructive popular treatise on the rocks and fossils of New York, with a brief review of the succeeding formations, not known in that State. It consists of about 65 pages of well written letter press, and is illustrated by 19 plates, containing some 220 good wood cuts of the characteristic fossils of the New York rocks;* together with sections showing the order of succession of the formations of that state, and of the more modern groups of strata occurring elsewhere.

"(C.) Contributions to Palæontology," by Prof. Hall, State Palæontologist, in which he describes with his usual clearness and precision, six new species, and one new genus of *Brachiopoda*—fifteen new species and two new genera of Univalves—and three new species of *Cephalopoda*. One of the univalves, *Euomphalus Conradi*, described on page 107, appears to be identical with a species figured and described by Mr. Billings under the name of *E. DeCuvi*, in the July number of the Canadian Naturalist. If so, Mr. Billings' name will have to take precedence, since the paper in which it was figured and described was issued in advance of Prof. Hall's. Even if the two papers were exactly contemporaneous, Mr. Billings' name would still be entitled to preference according to the usages of naturalists, since his description was accompanied by a good figure, while that of Prof. Hall was not.

Since the publication of the above, we have also received a continuation of Appendix (C.) of the Regent's Report, issued in two parts. The first 24 pages came out in August, and the remaining 60 in September. In this continuation Prof. Hall describes from the Hamilton and Chemung Groups, Schoharie Grit, &c., a number of new fossil shells, *Trilobites*, &c., which we have not space to notice in detail. On page 53 we observe he gives a "Supplementary note to pages 95 and 96 of the 13th Annual Report of the Regents on the State Cabinet," in which he materially modifies his views in regard to the Goniatite Limestone at Rockford, Indiana. In the 13th Report of the Regents, he describes a number of fossils from this rock, and referred it to the horizon of the Marcellus shale. In the supplementary note mentioned above, he carries it up to the Chemung Group. It will be remembered that in the September number of this Journal, Meek and Worthen published a paper on the age of this Goniatite Limestone showing that it could not be of the age of the Marcellus shale, but evidently holds a higher position.†

One of Prof. Hall's species, a *Spirorbis*, described on page 84—the last page of the continuation—was by an oversight left without a name.

* These are mostly the same cuts used in the N. Y. Geological reports, and the former Reports of the Regents of the University.

† Meek & Worthen's paper was in type in June, but was crowded out of the July number by a press of other matter, and laid over until the Sept. number.

7. *Mr. Marcou on the Taconic and Lower Silurian Rocks of Vermont and Canada.*—We have received a paper on this subject, read before the Boston Natural History Society on the 6th of November last, and published in their proceedings. In it, Mr. Marcou discusses the vexed question which has lately been so often before our readers, who are well aware that Mr. Emmons first gave the name of the Taconic system to the oldest Palæozoic rocks of North America. The late Prof. Eaton, who shares with Maclure the honor of having founded American geology, taught that the rocks between the Green mountains and the Hudson were older than those to the west of that river. He divided all stratified rocks into three classes, carboniferous, quartzose, and calcareous; by carboniferous, understanding schistose or argillaceous strata, and including in the carboniferous division of the first or primitive series, the gneiss and crystalline schists of the Green mountains; above which he placed the first quartzose and calcareous formations, the lower Taconic of Emmons. In the second or transition series, he placed the argillites and sandstones which are to the east of the Hudson, and are followed by his second calcareous formation, which seems to have included the Trenton group of limestones, and was succeeded by a third or lower secondary series. (Eaton's Geol. Text-book, 1832.) In opposition to the facts of physical structure, he supposed these formations to dip successively to the westward. The incorrectness of this latter view was perceived by his pupils, and Mr. Emmons, still maintaining the succession adopted by Eaton, included the 1st quartzose and calcareous, and the 2d carboniferous and quartzose in his Taconic system. This according to him underlies the Potsdam and Calciferous formations of New York, which are found horizontally resting upon the disturbed Taconic strata. These latter are supposed by him to have been disturbed previous to the deposition of the Potsdam, by a series of parallel faults, with upthrows on the east side, and to have a general eastern dip; so that the newer strata seem to pass beneath the older ones, thus giving to the whole the aspect of an inverted series. In defining this view, as Mr. Sterry Hunt has shown in the last number of this Journal; (p. 135,) Mr. Emmons has incorrectly spoken of them as inverted strata, while it is evident from his descriptions that he means to assert no more than *an apparently inverted succession.*

The Primordial fauna recognized in these rocks by Emmons and Billings, has attracted the attention of Mr. Barrande, who has lately given in the Bulletin of the Geological Society of France, an excellent and elaborate memoir; in which he discusses the various publications of Mr. Emmons, and those of other American geologists bearing upon the Taconic question. In this memoir, Mr. Barrande has apparently been led into error by the language of Mr. Emmons, and speaks of the overturn of the whole system. Dr. Hitchcock has also called attention to another misconception of Mr. Barrande, who says that Sir William Logan's published views about the Quebec group are "a formal recognition" by that geologist "of the Taconic system at the base of the Lower Silurian." (Bulletin, p. 320.) Now, as Dr. Hitchcock remarks, the rocks in question are by Sir William Logan regarded as the equivalent of the Potsdam and Calciferous formations, with which Mr. Barrande appears to confound

them; while the whole Taconic system, according to Emmons, lies beneath these formations. (Hitchcock; Geology of Vermont, p. 386.)

But if the Taconic system has been misunderstood by Mr. Barrande, it has now been completely travestied by Mr. Marcou. Let us compare the system as defined by its author, with the view of it given by Mr. Marcou in his late communications to the French Academy, and in the paper now before us.

1st. Mr. Emmons asserts that the Potsdam and Calciferous repose unconformably on the upturned Taconic series. Mr. Marcou, on the contrary, while he follows the Canadian geologists in referring the sandstones and dolomites of St. Albans to the Potsdam, makes them at the same time members of the Taconic system.

2d. Mr. Emmons expressly states that the gneiss and crystalline schists of the Green mountains formed the eastern limit of the original Taconic basin; and that throughout the Appalachian range the ruins of these strata formed the lower Taconic rocks. Mr. Marcou, on the contrary, includes all the gneiss and mica schist of Vermont as a portion of the Taconic series.

3d. Mr. Emmons, as we have already seen, maintains that the rocks of his system owe their apparently inverted succession to a series of dislocations and upthrows; hence it results that the newer seem successively to pass beneath the older strata, the whole series having a general eastward dip, towards the Green mountains. Mr. Marcou, on the contrary, asserts that "crystalline and eruptive rocks occupy the centre of the Green mountain chain, and that the Metamorphic and other stratified rocks have been turned over on each side, to the east and the west, presenting the fan-shaped structure, and all the accidents which accompany a complete overturn of a whole system of strata." (*Comptes Rendus*, Nov. 4, 1861.) To those who are familiar with the geology of the Green mountains this statement is certainly startling. The eruptive rocks of the chain are confined to a few small trappean dykes, and the granites are evidently strata altered in place. See farther on this subject, the Geology of Vermont, p. 572. As for great overturns from the centre of the chain, it is simply a fiction of Mr. Marcou's invention, unsupported by a single fact. Can Hitchcock, Emmons and others, who have grown gray among these hills, have overlooked a condition of things, which is apparent to a tourist who spends a week in the region? We conceive Mr. Emmons to have erred in his explanation of the physical structure of the Vermont rocks; but it is at any rate conceivable, and to a certain extent countenanced by the fact that at least one such great fault as he supposes, does occur to the west of the Green mountains, bringing up older strata, so that they overlap younger ones. We may here however say for the benefit of Mr. Marcou, that his notion of the structure of mountain chains is a fiction of the last generation; and that although he compares his imagined structure of the Green mountains with that of the Alps, every one who is familiar with modern Alpine geology is now aware that the fan-shaped arrangement of the strata described by De Saussure, is an evidence of a synclinal and not of an anticlinal structure. Mr. Marcou should further be informed that the granites of the Alpine summits, instead of being, as was once supposed, eruptive rocks, are now known to be altered

strata of newer Secondary and Tertiary age. A similar structure holds good in the British Islands, where as Sir Roderick Murchison has shown in his recent Geological map of Scotland, Ben Nevis and Ben Lawers are found to be composed of higher strata, lying in synclinals. This great law of mountain structure would alone lead us to suppose that the gneiss of the Green mountains, instead of being at the base, is really at the summit of the series. The strata between this gneiss and the Hudson River formation of the shore of Lake Champlain, we believe to be on the whole in their normal order; while the Georgia slates and the red sandrock which Mr. Emmons places at the summit of his Upper Taconic series, are (with the exception of the small Laurentian area in West Haven,) the most ancient strata in Vermont.

We cannot here stop to discuss Mr. Marcou's remark about "the unstratified and oldest crystalline rocks of the White mountains" which he places beneath the lower Taconic series. Mr. Lesley has shown that these granites are stratified, and with Mr. Hunt, regards them as of Devonian Age. (This Journal, vol. xxxi, p. 403.) Mr. Marcou has come among us with notions of mountains upheaved by intrusive granites, and similar antiquated traditions, now, happily for science, well nigh forgotten.

But to return; we have already said that Prof. Emmons places in the Upper Taconic series, the Georgia slates containing *Paradoxides*, and the sandstones with *Conocephalites;* while beneath them, and in the lower Taconic, he ranges the Stockbridge limestones (Eolian limestones of Hitchcock,) with slates above and granular quartz rock below them; the whole series being by him regarded as destitute of fossils. Now if it should happen that these strata contain fossils, and these should be found to have a newer aspect than those of the Georgia slates, it would show that Mr. Emmons has misunderstood the whole structure of the region, and that the apparent succession of the strata is the true one. In the recently published report on the Geology of Vermont we find a list of the fossils up to this time found in these Stockbridge limestones, and identified by Prof. James Hall. The genera are as follows: *Euomphalus, Zaphrentis, Stromatopora, Chætetes, Stictopora* and crinoids (p. 419); while the underlying quartzites contain *Scolithus*, a *Lingula*, fragments of crinoids, an orthoceratite and a *Modiolopsis?* (p. 356). Surely these are not the organic forms which are to be expected in strata far below the horizon of *Paradoxides, Conocephalites* and *Atops.* On the contrary they evidently belong to a higher fauna, and sustain the view of our friend Mr. Sterry Hunt, that the Stockbridge or Eolian limestones belong to the Quebec group, or are of the age of the Calciferous and Chazy (this Journal vol. xxi, p. 402.) We are not yet prepared to go the length of Dr. Hitchcock, who conceives that they may be Upper Silurian or Devonian.

At page 374, in the Geology of Vermont, we have a view of the St. Albans section, in which the conformable superposition of the red sandrock series to the Hudson River group, is admirably shown; so that Mr. Hitchcock remarks "the natural inference from these relations is that the red sandrock is of the age of the Oneida or the Medina sandstone, and the Georgia slate, still newer, and therefore Middle Silurian. * * * If one wished to establish a palæontological system from the stratigraphical relations of the rocks containing the fossils under consideration, there

is hardly a place to which we would refer with such confidence for the true order of the strata, as to these rocks in St. Albans." p. 375.

This accords with Sir William Logan's remark about similar sections near Quebec. He says "from the physical structure alone, no person would suspect the break that must exist in the neighborhood of Quebec, and without the evidence of fossils, every one would be authorized to deny it." (This Journal, vol. xxxi, p. 218.) To this testimony of Sir William Logan, so strikingly confirmed by Dr. Hitchcock, Mr. Marcou alludes, remarking that he can find no facts showing any conflict between palæontology and stratigraphy; an assertion which in the eyes of all who understand the question, will be most charitably regarded as evidencing only his own ignorance of the question. We have no doubt from the palæontological evidence, that a great dislocation and overlap exists both at St. Albans and at Quebec.

Not content with having annexed the Green mountain gneiss to his Taconic system, Mr. Marcou next proceeds to discuss the Laurentian and Huronian rocks of Canada in this wise. Sir William Logan, he tells us, having found some Taconic rocks on the southern edge of the Laurentide mountains, "proposed to introduce into the table of the American strata two new systems, which he called the Laurentian and Huronian systems. The Laurentian system is composed of the Lower Taconic, to which are added all the unstratified crystalline rocks forming the centre of the Laurentide mountains, such as granite, syenite, diorite and porphyry, mixing together strata and eruptive rocks; an attempt which was unexpected from a stratigraphical geologist. His Huronian system is formed from a mixture of the St. Albans group of the Upper Taconic with the Triassic rocks of Lake Superior, the trap native-copper-bearing rocks of Point Keweenaw, and the dioritic dyke containing the copper pyrites of the Bruce Mine on Lake Huron." p. 247. Comment upon such a display of ignorance and misrepresentation is almost unnecessary. As to the Laurentide mountains, of which Mr. Marcou knows absolutely nothing, we may state that one of their most remarkable features is the almost complete absence of unstratified rocks. The gneiss, hypersthene rock, quartzites and limestones, which make up their 40,000 feet, are all most clearly interstratified, and are lithologically entirely distinct from the gneiss of the Green mountains, a fact upon which Eaton insisted thirty years ago. (Geological Text-book, 2d edit., 1832.) For a map of the Laurentian limestones, showing their distribution, see the Geol. Survey of Canada, Report for 1859. This system has been identified and recognized by Sir Roderick Murchison as identical with the fundamental gneiss of western Scotland, which he now calls Laurentian; an additional reason, in Mr. Marcou's eyes, for denying the existence of the Laurentian system. As for the Huronian series, with its 10,000 feet of quartzites, conglomerates and diorites, so carefully studied and described by Mr. Murray, it neither includes Mr. Marcou's favorite Trias, (the Ste. Marie sandstones, which all the world now knows to be overlaid conformably by the Black River limestones,) nor the rocks of Keweenaw Point, the Upper Copper-bearing series of Sir William Logan; which he shows to be in the stratigraphical position of the Ste. Marie sandstones, and to rest horizontally on the upturned Huronian strata. As for the error that would make

the stratified diorites of Lake Huron a dyke, comment is unnecessary. Mr. Marcou tells us that the labors of Messrs. Jewett, Billings, G. M. Hall, Perry, Farnsworth, Richardson, Bell and himself, have resulted in the collection of more than 1200 species of fossils from the Calciferous sandrock. Now the whole number of species yet described from this formation by Prof. James Hall, Vanuxem and Billings, including the Point Levis fossils, is not much more than 200. As for the additional 1000 species, Mr. Marcou's reiterated statement is either a mistake or a great exaggeration, though we do not doubt that farther researches must add to the fauna of these rocks. It will be noticed that in the lists of fossils given by Mr. Marcou, he does no more than make a display of the names cited from Mr. Billings's late published descriptions.

A word about Sir William Logan's sections, given in the *Canadian Naturalist* for June last, in a paper on the Quebec and Lake Superior rocks, which will appear in the next number of this Journal. Mr. Marcou chooses to confound the actual section from Montmorenci to Orleans Island, with an ideal one showing the supposed mode of deposition of the Palæozoic strata of eastern North America. To this section, and not to the actual one observed near Quebec, belongs the series cited by Marcou on page 247; which includes the strata from the lower black shales of the Potsdam to the top of the Birdseye and Black River limestone. In this section, Sir William makes no reference to Quebec; nor has he, as Mr. M. would imply, anywhere described the Potsdam shales or the Black River limestones as visible in that vicinity. In noticing the section from Montmorenci to Orleans Island, Mr. M. regrets that having no diving apparatus, he could not satisfy himself that the bottom of the intervening river is occupied by Utica and Hudson River rocks. The evidence of this given by Logan, is however very simple, being the occurrence of Utica fossils, alike at the foot of the Fall and on the adjacent shore of the island, to the north of the great fault. Here we must pause to congratulate Mr. Marcou upon one correct observation made by him at Montmorenci. In the Proceedings of the Boston Natural History, for December, 1860, Mr. M. gave us his views on the geology of that place. Logan had long before stated that the horizontal strata at the summit of the Fall are Trenton limestone, with its characteristic fossils, and that the same rock, inclined at a high angle, is found at the foot; where it has been let down by a fault, and is succeeded by the Utica slates and the Hudson River group. Mr. Marcou however, from his observations on a memorable day (the 28th September, 1849, he tells us,) was enabled to declare that Sir William Logan was altogether wrong. The limestone at the summit, Mr. Marcou referred, with some doubt, to the Niagara period, but he did not see the same rock described by Sir William at its foot, and says "it is difficult for me to believe that fifty feet of limestone could have escaped my notice." He moreover asserts, with all the emphasis of italics, that "the quartzite and mica schist *have upheaved the bituminous black slates, and the almost horizontal strata of limestone have been deposited after the dislocation.*" His visit to Montmorenci last autumn however taught him better, and he now tells us that the limestone "*at the top of the fall and at the foot of the precipice, immediately in contact with the quartzite, are of the Trenton limestone age.*" p. 249. The italics this time are our own. He moreover says that in 1849, he erroneously considered the black slates

below as older than the Trenton limestone, and admits that they contain the characteristic Utica fossils; which, as Sir William Logan has shown, occur likewise on the north side of the island of Orleans. It is a man guilty of mistakes of this kind who ventures, with his notes of a few days' tour, to correct the results of years of patient labor. The nature of the crystalline rock at the fall seems to cause Mr. Marcou no little perplexity. In 1860 he called it "quartzite passing into mica schist, (gneiss of Messrs. Logan and Bigsby.)" In his paper now under review, he calls it Taconic, and describes it as "a quartzite, which Mr. Logan, for an unknown reason, persists in calling Laurentian gneiss." In his last communication to the French Academy however, (*Comptes Rendus*, Nov. 18, 1861), he himself speaks of "*the gneiss of the Fall of Montmorenci*" as a part of the crystalline rocks of the Laurentide mountains. We congratulate Mr. Marcou that he is, little by little, admitting the correctness of Sir William Logan's original description of Montmorenci.

But we must conclude this notice, which the opportunity afforded by it to discuss the interesting theme of the Taconic rocks, has led us to protract beyond the limits at first intended. The rocks of Vermont and Canada still require much study, before the details of their structure can be fully known, but we think that it is evident that in the red sandrock and the lower black shales we have the Primordial zone, of which the original Potsdam sandstone is a member. These we believe to be, with the exception of the small Laurentian area, the oldest rocks of Vermont, and we conceive that the whole series of Lower Taconic rocks, which Emmons and Marcou place beneath these, will prove to belong to the second fauna, if not in part to still newer rocks. So that Mr. Emmons' claim for the Taconic, as a system of strata older than the Potsdam age, is as yet unsupported by any evidence. T.

[NOTE.—In reference to certain charges of a personal nature brought by Mr. Marcou against the editors of this Journal and contained in this brochure—it is perhaps needless for us to say that they are wholly unfounded. The reference to Prof. Dana in the paper is also without foundation as he never saw the article referred to, owing to ill health, until months after it was printed.]

III. ASTRONOMY AND METEOROLOGY.

1. *On the Companion of Sirius;* by Prof. G. P. BOND, Director of the Observatory of Harvard College.—The companion of Sirius, discovered by Mr. Clark on the 31st of January, with his new achromatic object-glass of *eighteen and one-half* inches aperture, I have succeeded in observing with our refractor as follows:

Angle of position,	85° 15′	± 1°·1
Distance,	10″ 37	± 0″·2

The low altitude of Sirius in this latitude, even when on the meridian, makes it very difficult to catch sight of the companion, on account of atmospheric disturbances; when the images are tranquil, however, it is readily seen. It must be regarded as the best possible evidence of the superior quality of the great object-glass, that it has served to discover this minute star so close to the overpowering brilliancy of Sirius. A

defect in the material or workmanship would be very sure to cause a dispersion of light which would be fatal to its visibility.

It remains to be seen whether this will prove to be the hitherto invisible body disturbing the motions of Sirius, the existence of which has long been surmised from the investigations of Bessel and Peters upon the irregularities of its proper motion in right ascension.

A discussion of the declinations of Sirius, establishing a complete confirmation of the results of Bessel and Peters, has been recently completed and published by Mr. Safford. The following passage is extracted from the last Annual Report of the President of Harvard College. Alluding to the operations at the Observatory, the Report gives, as the conclusion of this discussion, "an interesting confirmation of Bessel's hypothesis that the star revolves around an invisible companion in its near vicinity;—the period of revolution is about fifty years."

It will require one, or at the most, two years to prove the physical connection of the two stars as a binary system. For the present we know only that the *direction* of the companion from the primary accords perfectly with theory. Its faintness would lead us to attribute to it a much smaller mass than would suffice to account for the motions of Sirius, unless we suppose it to be an opaque body or only feebly self-luminous.

2. *On the Discovery of the Asteroid* (72); (communicated by Prof. G. P. Bond, Director of the Observatory of Harvard College.)—In reducing the positions of the asteroid Maja, made at the Observatory of Harvard College in April and May last, Mr. T. H. Safford had occasion to refer to the observations made by Dr. Peters at the Observatory of Hamilton College, published in Brünnow's Astronomical Notices, No. 27, p. 20. The first three of these, namely, those for May 9, 11 and 12, were found to agree with the nearly cotemporaneous ones made here, but the remainder presented an unaccountable discrepancy.

A comparison with Mr. Hall's ephemeris of Maja, published in the Astronomische Nachrichten, No. 1315, showed that the Cambridge series entire, and the first three of the Hamilton College positions, belonged to Maja; but the remaining eight, from May 29th to June 13th, differed widely from the ephemeris. That the latter was not at fault, was proved by its accordance with all the Cambridge positions.

The systematic character of the differences, suggested, as a possible explanation, that Dr. Peters had, in the interval between May 12th and 29th, left the track of Maja, and fallen upon a new planet. Mr. Safford proceeded to verify this conjecture by computing from Dr. Peters' published observations of May 29th, June 7th and 13th, the following elements, which have a decidedly asteroidal character:—

1861. May 29·3851 Wash. m. t.

M	221° 24′ 45″·6
π	350 28 7 ·3
Ω	208 37 18 ·8
i	5 20 2 ·6
φ	8 21 49 ·8
μ	1253″·997

The observations, as printed, furnished only approximate positions, for want of accurate places of the comparison stars. The latter have since been supplied from the Harvard Zones. The elements representing the corrected places are as follows:—

Elements of Asteroid (72); by T. H. Safford.

1861. May 29·375 M. T. Washington.

L	213° 3′ 24″·1	}
π	329 22 16 ·5	} M. eq. 1861·0
Ω	208 1 28 ·0	}
i	5 23 16 ·2	
φ	6 50 26 ·0	
μ	1129″·372	
log. a	0·331446	

An ephemeris roughly computed from the above, shows the following agreement with observation.

	c.—o. $\Delta\alpha$	c.—o. $\Delta\delta$		c.—o. $\Delta\alpha$	c.—o. $\Delta\delta$
May 29,	+1″	0″	June 7,	+2″	0″
30,	−1	−2	8,	−1	−2
31,	−4	0	10,	+3	−3
June 1,	−4	0	13,	+1	0

which leaves no doubt that the object in question is a new asteroid accidentally fallen upon in searching for one discovered but a few weeks earlier. Its mean distance from the sun is the least of the known group.

3. *The recently discovered Asteroids.*—As a name has at length been assigned to the asteroid (59); the names of (61) and (65) have been changed; and new elements have been computed for most of them, we now give a complete list of the asteroids discovered since 1859, with the most recently determined elements.

Berlin mean time.	(57) Mnemosyne.	(58) Concordia.	(59) Elpis.	(60) Dannë.
	1860. Jan. 1·0	1860. Jan. 0·0	1862. Jan. 0·0	1862. Jan. 0·0
L	28° 35′ 25″·6	162° 28′ 26″·1	109° 37′ 23″·7	73° 6′ 25″·4
π	52 53 13 ·0	180 17 24 ·0	17 4 43 ·2	342 44 12 ·7
Ω	200 5 25 ·1	161 11 39 ·8	170 21 58 ·8	334 16 57 ·9
i	15 8 1 ·6	5 1 6 ·7	8 37 53 ·4	18 16 32 ·9
e	0·1041157	0·0401686	0·1175831	0·1684354
μ	632″·4633	802″·2385	793″·2911	681″·4933
a	3·157287	2·694441	2·712789	3·003977

Berlin mean time.	(61) Echo.	(62) Erato.	(63) Ausonia.	(64) Angelina.
	1861. Jan. 0·8	1862. Jan. 0·0	1861. March 5·0	1861. April 0·0
L	38° 4′ 6″·5	96° 3′ 10″·7	177° 5′ 1″·5	170° 44′ 16″·7
π	98 28 25 ·3	34 4 53 ·4	269 4 44 ·3	126 28 10 ·5
Ω	191 57 53 ·0	126 11 3 ·7	338 4 8 ·2	311 2 28 ·4
i	3 34 21 ·5	2 12 21 ·1	5 46 48 ·0	1 19 40 ·0
e	0·1847204	0·1710999	0·1256800	0·1248301
μ	958″·43568	640″·49134	956″·490	809″·508
a	2·391621	3·130850	2·396360	2·678286

Berlin mean time.	(65) Cybele.	(66) Maja.	(67) Asia.	(68) Leto.
	1861. Jan. 0·0	1861. May 16·0	1861. May 3·0	1862. Jan. 0·0
L	181° 9′ 11″·2	183° 16′ 42″·3	250° 35′ 33″·5	282° 33′ 47″·2
π	258 10 1 ·2	43 54 23 ·8	306 31 55 ·4	358 57 32 ·0
Ω	158 25 36 ·1	8 11 59 ·8	202 31 32 ·5	44 37 54 ·7
i	3 24 24 ·7	3 4 8 ·8	5 57 5 ·9	8 10 16 ·5
e	0·1277782	0·1542290	0·1876756	0·1697848
μ	558″·1762	820″·71	945″·4575	789″·8
a	3·431547	2·653866	2·414960	2·722658

Berlin mean time.	(69) Hesperia.	(70) Panopæa.	(71) Niobe.	(72) ——.
	1861. April 30·0	1861. June 0·0	1861. Sept. 25·5	1861. May 29·6
L	158° 57′ 16″·3	253° 11′ 36″·7	322° 15′ 20″·8	213° 3′ 24″·1
π	118 19 45 ·1	299 3 0 ·2	221 59 19 ·0	329 22 16 ·5
Ω	186 54 58 ·5	48 21 0 ·3	316 18 7 ·4	208 1 28 ·0
i	8 27 26 ·0	11 14 37 ·1	23 17 57 ·5	5 23 16 ·2
e	0·1740296	0·2235450	0·1733417	0·1191068
μ	662″·0986	813″·222	775″·41536	1129″·372
a	3·062358	2·670127	2·756226	2·145092

In the above tables

L represents the mean longitude of the planet at epoch.
π " " longitude of the perihelion.
Ω " " longitude of the ascending node.
i " " inclination of the orbit to the ecliptic.
e " " excentricity of the orbit.
μ " " mean daily motion.
a " " semi-major axis of the orbit.

Comparing these elements with those of the asteroids previously discovered, we find that the asteroid nearest the sun is (72), with a mean distance 2·14 and a period of 1148 days. The asteroid most remote from the sun is Cybele, with a mean distance 3·43, and a period of 2322 days. The orbit of (72) is therefore nearer to that of Mars than to that of Cybele.

The asteroid whose orbit has the least excentricity is Concordia, its excentricity being 0·04; that which has the greatest excentricity is Polyhymnia, its excentricity being 0·337, which is considerably greater than that of any other known planet.

The asteroid whose orbit is least inclined to the ecliptic is Massillia, whose inclination is 0° 41′; that whose orbit is most inclined to the ecliptic is Pallas, whose inclination in 34° 42′.

Of the 72 asteroids whose orbits have been computed, 18 have their ascending node in the first quadrant; 24 in the second quadrant; 17 in the third quadrant; and 13 in the fourth quadrant.

4. *Discovery of a Telescopic Comet.*—A telescopic comet was discovered at this Observatory by Mr. H. P. Tuttle, at 3 A. M., Dec. 29th. The following observations and elements have been obtained.

Observations of Comet 1861, III, *made at the Observatory of Harvard College, Cambridge, U. S.* [By a provisional reduction.]

	M. T. Cambridge.	A. R.	Dec.
1861, Dec.	28, 18h 25m 34s	14h 12m 55s·3	−5° 12′ 39″
	30, 18 20 16	14 15 29 ·9	−1 24 42
1862, Jan.	1, 18 37 18	14 18 29 ·9	+3 9 31

The following elements have been computed by T. H. Safford, Assistant at the Observatory:—

T. 1861. Dec. 6·9867. M. T. Washington.
log. q, 9·92400
ω,* 331° 39′·10
Ω, 146 8 ·78 App. equinox Jan. 1, 1862.
i, 41 58 ·40
Motion retrograde.

The middle observation is represented as follows:

	c.—o.
$\delta\lambda \cos \beta$,	+0′·19
$\delta\beta$,	+0 ·03

The subjoined ephemeris may perhaps be useful for the reduction of observations.

18h Washington.	Comet's A. R.	Comet's Dec.	log. Δ
1862. Jan. 1,	214° 40′	+8° 8′	9·755
3,	215 39	8 36	9·714
5,	216 49	15 9	9·675
7,	218 19	22 59	9·638
9,	220 18	+32 3	9·609

About the 20th inst. it will approach the north pole.

* Distance of the perihelion from the ascending node in the direction of motion.

Elements of Comet III, 1861; by H. P. TUTTLE.

Perihelion passage, Dec. 7·2024. M. T. Gr.

log. q	9·923922
π	173° 27′ 42″·7
Ω	145 7 59 ·4 M. eq. 1862·0
i	41 51 54 ·2

Motion retrograde.

From observations of Dec. 28th, Jan. 1st, 4th, and 7th.

4. *Encke's Comet.*—The physical phenomena which this comet has exhibited on several previous occasions, have been again repeated during its present apparition. At first it was quite destitute of any central condensation—more so in fact than is common with even the faintest telescopic comets. This is its usual aspect when far distant from the sun. It soon acquired greater consistency and even exhibited an almost sparkling nucleus. It was for some time visible to the naked eye, and showed a respectable tail 1° in length.

Its most interesting peculiarity was a very decided disposition of its nebulosity on the side towards the sun, constituting a faint tail, as it were, opposed to the normal direction. This was formed a long time before the true tail made its appearance. It is by no means a new feature, as it is mentioned in its preceding apparitions by Struve, Schwabe, Wichman and others. In 1848 and again in 1852 it was particularly evident. The fact of its repetition in so many instances gives a kind of individuality to this comet, distinguishing it from most bodies of its class, and is interesting from its associations with its otherwise very remarkable character.

G. P. BOND.

Observatory of Harvard College, Jan. 3d, 1862.

5. *Shooting Stars of January* 2, 1862.—In Connecticut, a cold wind blew violently during most of the night of January 1–2, 1862, but the sky was clear. A lady in Hartford, in this State, who was up early on the morning of the 2d inst. saw at about $3^h\,45^m$ A. M. in the southern sky a luminous cloud moving from west to east, which was followed by others somewhat less luminous. Shooting stars appeared moreover to be unusually frequent, and were noticed by this observer for an hour ending at $4^h\,45^m$ A. M. They were very numerous and at times as many as three per minute were seen. They passed from north to south, appearing most thickly near the zenith. I have not succeeded in ascertaining that this phenomenon was observed by any one else.

It is not easy to interpret the luminous clouds above reported, or to infer what was the actual number of shooting stars visible in the sky at Hartford during this hour. The statement adds however new strength to the probability that the 2d of January is one of the meteoric periods. In his valuable *Catalogue des Principales Apparitions d'Etoiles Filantes*, published at Brussels in 1839, Mr. A. Quetelet cites two instances in which these meteors have been reported as uncommonly numerous on the morning of the 2d of January, viz. in 1835 and 1838 in Switzerland; and in his 2d edition (1841.) he adds two other cases, viz. in 1839 at Bossekop in Finland and in 1840 in Belgium. In 1825, January 2, about 5 A. M. a grand fireball was seen in Tuscany, Italy, and on the same night both before and after it appeared, falling stars were seen there in great numbers. (*Ferussac, Bull. de Sci. Math., Mai*, 1825.) In a paper published

by me in 1839, vol. xxxv, 1st series of the Amer. Journal of Science, this date was named as one of the possible meteoric epochs. Owing in part at least to the inclemency of the weather, this period has been generally neglected. It is to be hoped that hereafter it will receive the attention of observers, and that the average hourly number of meteors then visible, and the place of apparent radiation at this season may be determined.

E. C. Herrick.

6. *Large Meteors.*—Several large meteoric fireballs, as below specified, have recently been seen in this part of the country, and any person who can give definite observations on any of them, is desired to communicate them to the editors of this Journal.

(1.) 1861, Dec. 9, 6 A. M.; near Brunswick, Maine, one, moving from W. to E., breaking into three parts. (2.) Dec. 17, 4¾ P. M. near Buffalo, N. Y., one with train, in S.E. (3.) Dec. 25, at sunset, from Connecticut, one seen in the S. over the Atlantic ocean, S. of Long Island, moving slowly from 10° high obliquely to horizon. (4.) Dec. 30, 7 P. M., Hartford, Ct., one in S.W. passing slowly from α Cygni to Delphinus, exploding with noise like a pistol. (5.) 1862, Jan. 3, 7^h 17^m A. M., New York City, one apparently as large as a third the moon's diameter, with short train, going from E. to W. (6.) Jan. 5, at sunset, one seen at Setauket, L. I., N. Y., from N.E., sparkling. H.

7. *Catalogue of Meteorites and Fireballs from A.D. 2 to A.D. 1860*; by R. P. Greg, Esq., F.G.S. Lond. 1860, pp. 74, 8vo. (From Report of Brit. Assoc. for Adv. of Science for 1860.)—This important catalogue is partly a sequel to the series of reports on Luminous Meteors published since 1847 in the annual volumes of the British Association, and partly as a continuation and enlargement of a Catalogue of meteorites published by Mr. Greg, in the Lond., &c. Phil. Mag. for Nov. and Dec. 1854.

It comprises, with introductory and concluding statements and notes,

(1.) A tabular catalogue with supplement, (57 pages,) of meteorites, detonating meteors and large noiseless meteors, (about 1900 cases in all,) combined in one chronological series, from A.D. 2 to 1860, stating the place, month, day and hour of the occurrence so far as known, and in some cases the size, weight, direction, velocity and other particulars, but usually without reference to the book or journal authorizing each statement; a general reference being however given to the sources from which the material of the catalogue is derived.

(2.) Ten analytical tables showing the yearly, monthly and hourly distribution and direction when known. These analyses evince much skillful labor, and present many interesting results.

There may be no theoretical objection to mingling in one catalogue meteorites and large meteors, but it is hard to discriminate between the large and the small. Of meteors as brilliant as Venus there are probably several hundreds visible in the earth's atmosphere every day, and no catalogue can be made which shall comprise even a hundred-thousandth part of the large meteors, fairly so called, which have been visible in our atmosphere during these 1858 years. These meteors are only larger shooting stars, and there seems to be no special reason for separating them from the smaller, except that they are less numerous. Every case of meteorite, fire-ball or shooting star, of whatever size, whose velocity, altitude, or direction is ascertained even roughly, is worthy of careful record. All

other cases are of much less astronomical importance, except those in which meteors have appeared in showers or in unusually large numbers.

The work is one of great convenience and much value, notwithstanding some errors and omissions. These are however not more numerous than might have been expected in the first issue, and we have no doubt that the author with his well known zeal and thoroughness will render future editions yet more complete. H.

8. P. A. KESSELMEYER: *Ueber den Ursprung der Meteorsteine:* with three tables: (from the 3d vol. of "Abhandlungen der Senckenbergischen Naturforschenden Gesellschaft," at Frankfort-on-the-Maine.) Frk à-M. 1860. 4to, pp. 144.—The first 45 pages of this work are occupied with a discussion of the subject of meteorites, especially with reference to their mineral characters, and their distribution throughout the globe and throughout the year. Some account is also given of the history of the science and of the hypotheses which have been proposed to explain their origin. His own conclusion is the untenable one that meteorites are probably connected with the active volcanoes of our earth.

Three charts accompany the three tables, viz. (1) one of Europe showing the localities, by numbers referring to the extended table, of the meteorites which have fallen in Europe, and showing also the position of the active volcanoes there found; (2) one indicating in like manner the meteoric falls and the active volcanoes of the eastern hemisphere; (3) a similar map of the western hemisphere, with a side map of the United States bearing like data. These interesting maps show that the law of the geographical distribution of meteorites is a simple one, viz. meteorites have been found most abundant where intelligent observers have been most abundant.

On pages 45, 46, 47 is a catalogue of 130 European meteorite-falls since 1700, arranged and summed according to the months of their occurrence, and on p. 48 is a like catalogue of 23 cases in Asia since 1700.

The remainder of the book (pages 49 to 144 inclus.) is occupied with tables enumerating all known meteorites and meteoric irons, with their time and place of fall, if known, some other details, and references to the work wherein described. One series is arranged geographically (p. 49–84,) and another series gives in chronological order a catalogue of meteorites certain and probable, from the earliest times to the present day, distinguishing (not always successfully,) by difference of type in the number prefixed, between the certain and the doubtful. In his zeal for thoroughness the author has introduced numerous cases from Chinese Annals which may be somewhat uncertain, and begins his list with the case of the "fire from heaven" which destroyed Sodom, Gomorrah, Admah, and Zeboim. The total number is

	Of known date.	Of unknown date.
More or less certain stone-falls,	287	17
" " " " iron-falls,	17	97
" " " doubtful stone-falls,	337	24
" " " " iron-falls,	6	10
	647	148

Then follows a list, (p. 134–143,) of bolides and probable meteorites and meteoric iron masses. The work is well arranged, and furnishes the most useful aërolitic catalogue hitherto published. A few errors observed in it will hereafter be mentioned. H.

9. *Abstract of Meteorological Observations made during the year* 1861, *with the averages of nine years, at Sacramento, Cal.*, lat. 38° 31′ 41″ N., lon. 121° 29′ 44″ W. Altitude at the top of the levee, in front of the city, 54 feet 5 inches. Height of lower surface of mercury, 52 feet 5 inches above low tide at San Francisco; by THOMAS M. LOGAN, M.D.

1861.	January.	Feby.	March.	April.	May.	June.	July.	August.	Sept.	October.	Nov.	Dec.	Ann. Mean	Average.
Barometer.														
Maxima,	In. 30·445	In. 30·386	In. 30·289	In. 30·283	In. 30·199	In. 30·107	In. 29·930	In. 30·008	In. 30·084	In. 30·150	In. 30·383	In 30·297	In. 30·203	In. 30·233
Minima,	29·615	29·701	29·779	29·862	29·714	29·752	29·657	29·745	29 642	29·724	29·765	30·594	29·713	29·721
Mean,	30·180	30·103	30·063	30·027	29 942	29 916	29 812	29 890	29·877	29·975	30·029	30·042	29 984	30·001
Thermometer.	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.
Maxima,	57·00	62·00	69·00	74 00	75 00	81 00	87·00	84·00	81 00	73·00	65 00	62·00	72·50	76 99
Minima,	36 00	45·00	45 00	50 00	55 00	57 00	64·00	61·00	59·00	47·00	40·00	40·00	49 99	46·70
Minima,	47·12	52·17	56 05	60 65	63 70	66·18	73·57	69 73	67·78	59·91	58 60	50·98	60 12	59 92
Mean,	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.
Thermometrograph.	58·00	62·00	70 00	76 00	77·00	82·00	92·00	90 00	84·00	78·00	68 00	63·00	75·00	77·50
Maxima,	30·00	45·00	42·00	47·00	50 00	53·00	61 00	58·00	46·00	39·00	39·00	24·00	47·30	42 50
Minima,	28 00	17 00	28·00	29·00	27·00	31·00	32 00	27·00	32·00	29·00	29·00	24·00	27·70	35 00
Range,	In. ·376	In. ·407	In. ·446	In. ·551	In. ·619	In. ·545	In. ·639	In. ·577	In. ·595	In. ·470	In. ·439	In. ·439	In. ·500	In. ·517
Force of Vapor.	·139	·204	·228	·283	·263	·337	·403	·370	·367	·212	·182	·175	·264	·217
Maxima,	·257	·307	·340	·382	·397	·434	·501	·457	·464	·330	·312	·322	·367	·359
Minima,	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
Mean,	93 00	95 00	96·00	88 00	83 00	77·00	75·00	77·00	80 00	79 00	88·00	93·00	85 00	87·07
Relative humidity.	46·00	50 00	52 00	47·00	36·00	45·00	35·00	36 00	50·00	33·00	60·00	50·00	45·33	35 36
Maxima,	78·37	77·93	75 30	72 08	67·47	67 40	60·94	63 35	68 68	64·27	74·67	85·00	71·28	70·19
Minima,														
Mean,													204	1944
Number of clear days,	9¼	8¾	13½	16¼	21½	21¼	27¾	30½	27½	23¾	5¾	0	161	1704
Number of cloudy days,	21	19	17	13	9	8	3	0	2	7	24	31	65	61
Number of rainy days,	7	9	6	5	3	4	0	0	0	1	12	18		
Quantity of clouds,	3·2	3·3	2·3	1·7	1·2	0·7	0·2	0·02	0·1	0·9	5·5	5·9	4·2	3·6
Quantity of rain and fog.	2·668	2·920	3·320	0·475	0·590	0·135	0·000	0·000	0·000	0·000	2·170	8·637	23·201	18·019

Column 1st No. of days, and column 2nd force of														
N. wind	14 1·6	8 1·5	11 1·7	8 1·9	4 1·9	2 1·0	0 0·0	0 0·0	4 1·5	2 1·1	4 1·2	10 1·4	82 1·4	56 1·6
N.E. "	3 1·0	2 1·0	11 2·1	1 2·0	0 0·0	0 0·0	0 0·0	0 0·0	0 0·0	0 0·0	3 1·4	3 1·3	16 1·0	15 1·0
E. "	2 1·0	1 1·7	1 1·0	1 2·3	1 1·5	0 0·0	0 0·0	0 0·0	0 0·0	1 2·0	1 1·0	2 1·2	12 1·2	9 1·0
S.E. "	2 2·1	2 2·0	2 2·0	1 2·2	1 2·4	1 2·0	0 0·0	1 1·5	0 0·0	1 1·7	2 1·7	1 1·2	12 1·2	8 1·0
S. "	5 1·7	4 2·1	5 2·3	3 2·3	3 1·7	2 1·9	1 1·6	1 1·5	1 1·7	1 1·7	7 1·9	5 1·8	38 1·7	67 1·8
S.W. "	0 0·0	1 2·0	2 2·1	1 2·2	1 2·0	1 2·0	1 1·4	1 1·4	1 1·5	2 1·7	2 2·0	2 1·7	39 1·6	68 1·8
W. "	1 1·0	1 1·3	2 1·9	1 1·8	2 2·2	1 2·2	1 1·3	1 1·4	1 1·6	1 1·8	1 1·8	1 1·7	42 1·6	56 1·8
N.W. "	2 2·1	5 2·3	4 1·6	6 2·2	5 2·2	3 2·2	2 2·2	2 1·8	4 1·2	4 1·6	4 1·6	2 1·6	21 1·7	13 1·7
Quantity of rain and fog.	2·668	2·920	3·320	0·475	0·590	0·135	0·000	0·000	0·000	0·000	2·170	8·637	23·201	18·019

IV. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Letter from Prof.* Aug. De la Rive *respecting the paper of Mr. B. V. Marsh, on the Aurora, viewed as an electric discharge.* "Monsieur Silliman, Editor of the American Journal of Science and Arts:—*Sir:* No. 93 (May, 1861) of your Journal contains an article by Mr. B. V. Marsh, upon "*the Aurora viewed as an Electric Discharge between the magnetic poles of the Earth, &c.*" The author's ideas on the origin of the Aurora Borealis approach so closely to those which I put forth more than twelve years ago on this subject, that I fear my researches are unknown in America, although Mr. Marsh makes an indirect allusion to them in a note. Permit me then to recall to you in few words my claims to priority respecting the explanation of the phenomena of the Aurora Borealis.

I developed the theory of the Aurora Borealis for the first time in a letter to Arago in 1849 which was published in the *Annales de Chimie et de Physique.** On the same occasion I addressed a letter to Regnault inserted in *Comptes Rendus de l'Acad. des Sci. de Paris*,† in which to support my theory, I cite an experiment I had devised which showed the influence of a powerful magnet upon electrical discharges passing through a highly rarefied gaseous medium.

Later, in the third volume of my Treatise on Electricity,‡ published early in 1858, (by Longmans, London,) I have given a description and complete theory of the Aurora Borealis such as is now generally accepted.

The magnificent Aurora Borealis of 29th of Aug. 1859 went to confirm even in its minuter details the explanation which I have given of this phenomenon. This I have stated in a letter addressed to De Senarmont which appeared in *Comptes Rendus* (T. xlix, p. 424.) and which was followed by a second in the same volume, p. 662. I have also in the *Arch. des Sc. Phys. de la Bib. Univ. de Genève*, Sept. 1859, a detailed notice on the same subject, and finally I sum up in an article more general and extended, and published in the new series of the *Bibliothèque Universelle*, (Nov. 1859) my whole theory of the Aurora Borealis, supporting it by observations and experiments fitted to demonstrate its truth.

In these later publications I insist more particularly upon observations made during the occurrence of the Aurora, either in magnetic observatories or in telegraphic offices, as alike demonstrating the existence of currents of electricity directed from north to south in our hemisphere beneath and very near the surface of the earth. These currents in their discharge acting in the polar regions between the positive electricity of the atmosphere and the negative of the earth must, as I then said, (*C. R. de la Acad. des Sc.*, T. xlix, p. 665,) exist permanently but only with variable intensity according to the season of the year and the state of the atmosphere. When owing to favoring circumstances this intensity is considerable, the discharges are accompanied by the light, which in rendering them visible, constitutes the Aurora Borealis. I rest these considerations upon the frequent appearance of the Aurora Borealis, which is almost daily, in the polar region. As appears from the observations of Messrs. Lottin and Bravais, during their residence in Bossekop, and of

* Tome xxv, p. 310. "Sur les variations diurnes de L'Aiguille Aimantée et les Aurores Boréales." † Tome xxix, p. 412. ‡ Vol. III, p. 283.

those collected by Prof. Henry at the *Smithsonian Institution*., on the appearance of the Aurora in the Northern United States and in Canada.*

Quite lately a distinguished astronomer, Lamont of Munich, has demonstrated by direct observation the constant existence of electric currents flowing on the earth's surface from north to south in our hemisphere, so that what has been before a very probable conjecture is become an incontrovertible fact.† He has also established the existence of electric currents circulating from east to west over the surface of the earth. But these currents (the origin of which has no relation to that of the first named,) have nothing to do with the phenomena of the Aurora Borealis: their essential effect is to give to the magnetic needle its normal direction, although the others, (east and west currents) being much more variable in their intensity, only tend more or less to modify this direction.

In substance, I believe I was the first to demonstrate that the phenomena of the Aurora Borealis are the result of the combined action of terrestrial magnetism and the discharges which take place between the positive electricity of the atmosphere and the negative of the earth, and I consider it proved that even in the smallest detail of form, of appearance and the accompanying phenomena, the known laws of electricity suffice to give a perfectly satisfactory explanation.

Accept, sir, &c., AUG. DE LA RIVE.

Geneva, Oct. 15th, 1861."

We take pleasure in placing Prof. De la Rive's letter before the reader of this Journal, especially as it gives us an opportunity of disclaiming any intention on our part of doing the slightest injustice to the world-wide reputation of the distinguished Genevan Professor. The splendid phenomena of the memorable Aurora of 1859 gave occasion to apply anew the well known views of Faraday,‡ Hansteen, De la Rive and others, on the electrical character of the Aurora to the more complete elucidation of this interesting phenomenon. It certainly is to Prof. De la Rive that we owe the beautiful experimental illustration which bears his name, by means of which the action of magnetism on the electric light is demonstrated, and the existence of a luminous ring concentric with the boreal magnetic pole cutting at right angles all the magnetic meridians that converge towards that pole, had been proved by the observations of Hansteen. No doubt it would have been well if definite reference had been made to these points in which Mr. Marsh's results coincided, although without his having been at the time aware of the fact, with those before announced. But in publishing his paper we did not think it necessary to give a résumé of well known opinions on the subject under discussion. It was sufficient to authorize its publication that Mr. M. had collected data from which he had determined approximately the height not only of the arch but also of some of the streamers in the display of August 28, 1859,§ and with

* Prof. De la Rive evidently refers here to observations earlier than those of 1859. It will be remembered that one of the eight articles on that display which have appeared in this Journal from the pen of Prof. Loomis, viz. the 6th (in vol. xxx, p. 339) was made up of observations collected by the Smithsonian Institution.

† *Arch. des Sci. Phys. Bibl. Univ.* Sept. 1861.

‡ So far as we know, Faraday made the first definite suggestion resting on experimental data, that the Aurora might be due to the discharge of electricity. Expl. Researches, p. 56, § 192. January, 1832.

§ See Journal of the Franklin Institute, Philad., Nov., 1859.

this advantage, having at his disposal the vast mass of new data collected in the pages of this Journal,* together with the results of the recent electrical investigations of Plücker and Gassiot, he had from their consideration been able to evolve an explanation of the phenomena of the Aurora different in important respects from any that had before been offered. But there was certainly no intention on the part of any one to deprive Prof. De la Rive of the distinction of having been the first to discuss in a philosophical and detailed manner the electrical relations of the Aurora Borealis, as well in his Treatise on Electricity as in separate memoirs.

Book Notices.—

2. *Report of the Secretary of War, communicating, in compliance with a resolution of the Senate, Lieut. Michler's Report of his survey for an inter-oceanic ship canal near the Isthmus of Darien.* pp. 457, 8vo, with 17 maps.—The first 147 pages are devoted to the Journal, and the geographical and climatological papers, by Lieut. Michler, and they seem to have been arranged in a clear and systematic manner. We call attention with pleasure to the important and valuable information they contain.

Chapter VII contains Mr. Arthur Schott's report on the physiography of the Isthmus of Choco, 21 pages.

Appendix A. Remarks on the geognostic structure of the country, with accompanying descriptive table of geological specimens; by Arthur Schott, 5 pages.

Appendix B. Botany—Algæ, by Prof. W. H. Harvey, with notes by Arthur Schott—4 pages.

Appendix C. Filices and Lycopodiacæ, by Daniel C. Eaton, with notes by Arthur Schott. Two new species, *Lindsæa* (*Dietyoxephium*) *Michleriana*, *Aspidium Draconopterum*, pages 11.

Appendix D. Botanical notes, pages 21.

Appendix E. Zoology—Mammalia, by Arthur Schott, pages 7.

Appendix F. Birds, by John Cassin, pages 35. 1 new genus, *Pittasoma* and 5 new species of birds are described:—*Monasa pallescens*, *Celeus mentalis*, *Orthogonis olivaceus*, *Pittasoma Michleri*, *Dendroica Vieillatii*.

Appendix G. Reptiles and Amphibia; notes by Arthur Schott, pp. 2.

Appendix H. Fishes, by Theodore Gill, pages 3.

Appendix I. Invertebrata, pages 9.

The remainder of the report comprising 189 pages is devoted to the compilation of the results of the Geodetic Survey.

This report is certainly a valuable contribution to our knowledge of an interesting region, but the Natural History portion is sadly disfigured by numerous and gross typographical errors. Most of the scientific names are not familiar to proof-readers and in all cases the printers should submit the proof sheets to the respective authors, or some good naturalist, for correction. We regret that so few copies of this report have been published, as many persons to whom it would be useful must fail to obtain it. We hope to refer to it again more in detail at some future time.

3. *Annual Report of the Board of Regents of the Smithsonian Institution, for the year* 1860.—The "General Appendix" contains the following articles:—"Lectures on Roads and Bridges," by Prof. F. Rogers; on "Mollusca, or Shell-fish and their Allies," by Dr. P. P. Carpenter; a translation of "General views on Archæology," (illustrated,) by A. Morlot; and several other translations and extracts from European journals; also a note "On the disappearance of ice," by R. H. Gardiner; on "Differ-

* Vol. xxviii, 386; xxix, 92, 249, 386; xxx, 79, 339; xxxii, 71, 313.

ence of temperature in different parts of the city of St. Louis," by A. Fendler; on the "Best Hours for observations of Temperature," by Prof. C. Dewey; "On the Anemometer," (illustrated,) by Prof. Henry; "Suggestions for saving parts of the skeleton of Birds," (illustrated,) by Alfred Newton; "On the Wingless Grasshopper of Shasta and Fall River Valleys, California," (illustrated,) by Edward P. Vollum, M.D.; "Letter relative to the obtaining of specimens of Flamingoes and other birds from South Florida," by the late G. Wurdemann; "On the habits of the Pouched Rat (*Geomys pineti*) of Georgia," by W. Gesner, M.D.; and a "Catalogue of the Birds of Chester Co., Penn., with their times of arrival in Spring," by Vincent Barnard.

The longest of these articles is that on "Mollusca, or Shell-fish and their allies," (pp. 132,) which deserves more than a passing notice. Dr. Carpenter gives us, in a concise but very readable form, an account of the nature and habits of molluscous animals, and of their classification, down to the families;—being the substance of a course of lectures delivered by him at the Smithsonian Institution during his visit to this country in 1859–60. The subject is presented in a style quite new and interesting, which cannot fail to attract general readers. We observe the frequent occurrence of touches of quaint humor which are very refreshing amid scientific details, and remind us of those passages which contributed so much to render popular the writings of the lamented Edward Forbes. There are no technical descriptions and scarce any lists or tables to mar this style, but most of the genera are mentioned by name, and their differences pointed out. As an introduction to the science of Malacology the work cannot fail to prove exceedingly valuable.

The translation of Morlot's paper on Archæology will well repay the cost of perusal by those who have not read it in the original. The discoveries of the Danish archæologists in their "Kjoekkenmoedding" and other superficial deposits, and the discrimination of three pre-historic ages, that of Stone, Bronze, and Iron, form a well marked era in the science. We may now no longer depend upon semi-fabulous histories or obscure traditions for our knowledge of the early characteristics and distribution of man on the earth, but may study him in the remains of himself and his works, with the same certain results which attend geological investigations. Archæology in fact is but a branch of geology.* In connection with Morlot's paper several more recent works may be read with interest. Such are:

Habitations lacustres des temps Anciennes et Modernes, par F. Troyon, Lusanne, 1860.

On the Crania of the most ancient races of men; by Prof. D. Schaffhausen of Bonn. Translated, with remarks and original figures, by Geo. Busk. Nat. Hist. Review, April, 1861.

The Kjökkenmöddings: recent Geologico-Archæological Researches in Denmark; by John Lubbock, Esq., F.R.S. Nat. Hist. Review, Oct., 1861.

The discovery of implements of human workmanship in the gravel beds of Amiens, beneath a series of strata which must have required many centuries for formation, and associated with remains of extinct

* For a paper by Morlot on the same subject see this Journal, [2], xxix, 25.

mammals, distinguishes a period even earlier than the Stone Age of the Danish savans, and points to a much greater antiquity in the appearance of man upon the geological stage than has been hitherto supposed. The most ancient skulls (those found in the caverns) of which we have any knowledge, are of a very low type in the sharpness of their facial angle and in the prominence of the superciliary ridge, showing an approach to that of the higher Quadrumana. The great impulse now given to these investigations must tend to further discoveries, which cannot fail to enlighten us much in regard to the origin of the human races, now so obscure. We may ascertain whether any intermediate types have been created, and if so, what has been the range of their development,—matters about which we can now only speculate. To those who object to such speculations we may observe that, in a religious point of view, it matters little by what method the Creator made physical man, when we know that his creation as a spiritual and accountable being dates with the time when He "breathed into his nostrils the breath of life, and man *became* a living soul." W. S.

5. *On the Ornithology of Labrador;* by ELLIOTT COUES. pp. 215–257.—Mr. Coues visited the coast of Labrador in the summer of 1860, under the auspices of the Smithsonian Institution. He gives us a list of the birds observed by him there, with much interesting information concerning them. Very full accounts are given of the habits of water-birds, particularly of *Utamania torda* (Razor-billed Auk), and *Mormon arcticus* (Puffin), which the author had abundant opportunity of observing. Of *Mormon arcticus* he says, "I observed not the slightest indication of any sympathy for those wounded or killed, on the part of the other birds, as stated by Audubon." The case is different however with an allied species (*M. corniculatus*) observed by the author of this notice in Behring's Straits. Upon one of these birds being shot, the others gathered around it as it floated upon the water, anxiously pecking at it and tearing at the wounds, so intently indeed that they were not driven away by repeated discharges of the fowling piece at a short distance. Whether this was sympathy or not we could not determine,—in appearance it was rather a furious attack. The paper is chiefly valuable for its important additions to our knowledge of the geographical distribution of North American birds. *Turdus aliciae* was found breeding in abundance;—it was formerly known only in the Mississippi and Missouri regions. *Saxicola œnanthe* is carefully compared with the European bird, and found to be identical. A new species (*Aegiothus fuscescens* Coues,) was discovered;—a rare occurrence in Eastern North America at this late day.—*Proceedings of the Philadelphia Acad. Nat. Sci.*, 1861. W. S.

6. *Post-pliocene Fossils of South Carolina;* by FRANCIS S. HOLMES, A.M., Professor of Geology and Palæontology in the College of Charleston, South Carolina, etc. 4to. Russell & Jones, Charleston, S. C., 1860. —This important work, the commencement of which has already been noticed in this Journal, ([2] xxix, 228) was completed more than a year ago. The part relating to the Vertebrate Fossils has been already reviewed, and received the commendation which it deserves. We now propose to discuss the Invertebrata only. The formation named in the title is more extensively developed in South Carolina than in any other state in the Union, and we may congratulate geologists upon the possession of a work illustra-

ting its fossils, by an author who has had such good opportunities for their study, and who could furnish such excellent plates. The figures, as a rule, are exceedingly well executed, and we therefore may excuse an occasional failure, (as in those of *Axinœa charlestonensis*, *Chama arcinella*, and *Liocardium Mortoni*, which are "blots,") in view of the general excellence of the work. It would have been better to have magnified the smaller bivalves. The work is equally valuable to students of recent conchology, as several existing species are here for the first time figured. The *descriptions* are, for the most part, extracted from the works of previous authors. The generic nomenclature of the shells is chiefly that of H. and A. Adams, excepting where those authors have not mentioned the particular species in their work. Thus such "genera" as *Peronœoderma* and *Angulus* are adopted, while *Strigilla flexuosa* and *Macoma cayennensis* are placed in *Tellina*. In fact we must protest against some of the nomenclature used by Prof. Holmes, although, as a very full synonymy is given, we can easily select more appropriate names. It is somewhat startling, for instance, to see our common sea-urchin, *Echinocidaris punctulatus*, figured and described as "*Anaperus carolinus* Trosch." Now the *Anaperus carolinus* is a "biche-le-mar,"—the *Holothuria briareus* of Le Sueur,—the soft body of which is not exactly adapted for preservation in post-pliocene sands. "*Schizaster atropos*" is *S. lachesis* Grd. "*Guia punctata*" should be *Persephona p.* We have the *Ostrea fundata* of Say (MSS.) now for the first time described and figured; it is a good species and must be credited to Prof. Holmes. "*Nucula acuta*" is a *Leda*. "*Leda limatula*" is a *Yoldia*. "*Cardium Mortoni*" is a *Liocardium*. "*Lucina Kiawahensis* n. sp." is not a *Lucina;* it looks more like *Diplodonta* or a Venerid. "*Dosinia concentrica*" is *D. discus* Reeve. "*Tapes grus* n. sp." is *Chione pygmœa*. "*Mya simplex* n. sp." is probably *Paramya subovata* Con., which is both Miocene and recent. "*Saxicava fragilis* n. sp." is probably a worn valve of *Solenomya velum*. "*Fusus minor* n. sp." appears to be a young shell, perhaps *Columbella avara* or *similis*. "*Fusus conus* n. sp" is a tip of *Columbella translirata* Rav. "*F. filiformis* n. sp." is the tip of a *Mangelia* common on the coast. "*Fusus bullatus* (!) n. sp." is a young *Nassa*, probably *N. trivittata*. "*F. rudis* n. sp." is a tip of *Mangelia rubella* K. and S. A little *tipical* knowledge is quite necessary to an investigator of fossil shells. "*Volva acicularis*" is *V. intermedia* Sow. Prof. Holmes quotes Gould for *Natica pusilla*, but Gould's shell is quite different from Say's, and is the *Lunatia grœnlandica* of Beck. "*Adeorbis nautiliformis* n. sp." is *Cochliolepis parasitica* Stm., while the shell figured as *Cochliolepis* is a *Vitrinella*.

It is important to make these corrections, as they seriously affect the percentage of extinct species found in our Post-pliocene deposits. The following species described as new seem to be really so, as far as we can judge from the figures.

Montacuta Bowmani,
Mulinia Milesii,
Mesodesma concentrica,
*Abra angulata,
Volutomitra wandoensis,
Turbonilla cancellata,
quinquestriata,
Turbonilla lineata,
subulata,
caroliniana,
acicula,
subcoronata,
*Obeliscus crenulatus,
Architectonica gemma.

Those marked by an asterisk, as well as more than half the *Turbonillæ*, are also found living on the coast. Prof. Holmes gives much valuable information as to the distribution of our shells, both in a recent and fossil state. The climate of the Post-pliocene period could have differed very little from that now prevailing in South Carolina. W. S.

6. *Descriptions of new Cretaceous Fossils from Texas;* by B. F. SHUMARD, M.D. (From the Proc. Bost. Soc. Nat. Hist., September 4th, 1861, page 16).—The fossils described in this paper are chiefly from the counties of Lamar and Navarro. Those from Lamar county are from Dr. Shumard's Red river group (see his Section, Trans. Acad. Sci. St. Louis, vol. i, p. 583), and correspond to Cretaceous formation No. 1, or Dacotah group of Meek and Hayden's Nebraska Section (= Jurassic, and probably Triassic in part, of Marcou). The fossils mentioned were mostly collected from the bluffs bordering Red river, and those from Navarro county came from an interesting series of beds not hitherto recognized in Texas. Most of them were obtained from Septariæ, imbedded in blue and gray arenaceous clays. More than fifty species of fossils have been found in these strata, a large proportion of them new to science, and now for the first time described. Others correspond with species described by Mr. Conrad from the Ripley Group [No. 5 or Fox Hills Beds—Nebraska Section, probably] of Tippah county, Mississippi and Eupaula, Alabama. The following species were recognized common to the Tippah and Navarro beds: *Nautilus Dekayi, Baculites Tippaensis, B. Spillmani, Purpura cancellaria, Rapa supraplicata, Strombus densatus, Ficus subdensatus, Pleurotoma Ripleyana, Pholodomya Tippana, P. elegantula, Cardium Spillmani, Legumen elliptica, Siliquaria biplicata, Pecten simplicius, P. Burlingtonensis* and *Exogyra costata.*" From the facts before us, we are inclined to think that the beds, from which the fossils, named above, were obtained, corresponded with No. 5 of the Nebraska Section. The following new species of fossils are described in this paper: *Scaphites verrucosus, Ptychoceras Texanus, Helicoceras Navarroensis, Turrilites splendidus, T. helicinus, Volutilithes Navarroensis, Ringicula pulchella, R. subpellucida, R. acutispira, Solidula Riddelli, Tornatella Texana, Cylichna striatella, C. secalina, C. minuscula, Scalaria Forsheyi, S. (scala) Lamarensis, S. (scala) bicarinifera, Ficus (Pyrifusus) granosus, Turritella Corsicana, T. Winchelli, Pleurotoma Texana, Pleurotomaria Austinensis, Anisomyon Haydeni, Scalpellum inæquiplicatum, Pholadomya Lincecumi, Panopœa subplicata, Ostrea Owenana, O. Lyoni, O. planovata, Crassatella lineata, C.? parvula, Cucullœa millestriata, Nucula bellastriata, Neœra alæformis, Avicula iridescens, Cyprina Laphami, Lucina parvilineata, Anatina sulcatina.*

The palæontological papers of Dr. Shumard always bear the stamp of careful and conscientious preparation, and their publication is hailed with pleasure. We are certain that scientific men, not only in this country, but in Europe, will ever regret that the survey of Texas, so ably inaugurated by Dr. Shumard could not have been completed under the same auspices.

7. *Lectures on the Science of Language, delivered at the Royal Institution of Great Britain, in April, May and June,* 1861. By MAX MÜLLER, M.A., Fellow of All Souls' College, Oxford: corresponding member of the Imperial Institute of France. London—Longman, Green, Longman

& Roberts, 1861.—The Lectures which this volume contains are an abstract of several courses delivered by Mr. Müller, from time to time, in Oxford. They are now presented to the public in the form in which they were prepared in MS. for delivery before the Royal Institution of Great Britain. They are an interesting contribution to the science of language, and it is with pleasure that we notice their publication.

In these lectures Mr. Müller has brought out of his treasure things new and things old. The advanced student of comparative philology will doubtless find in these pages much with which he is familiar, but he will not fail to appreciate the clearness with which the subjects are treated. To the general reader also this book will be attractive. There is no thick layer of the "dust of the schools" upon it. Indeed, there is a vivacity in the author's style which places the work within the class of the *readable*. Mr. Müller seems to combine the depths of German research with much of the happy talent of exposition eminently characteristic of French authors. This is no slight merit—especially in a writer upon the science of language. The science itself is of modern date. Indeed, as Mr. Müller observes, its very name is as yet unsettled. Those who have penetrated into the recesses of some newly discovered temple and have learnt where to seek for its long hidden treasure, are entitled to a double meed of praise, when they succeed in attracting attention to their discoveries by a felicitous description of them.

In his first lecture, Mr. Müller very happily states the claims of this modern science, which is so much indebted to Wilhelm von Humboldt, Bopp, Grimm, and others of this century.

"The problem" says Mr. M. "of the position of man on the threshold between the world of matter and spirit, has of late assumed a very marked prominence, among the problems of the physical and mental sciences. It has absorbed the thoughts of men who after a long life spent in collecting, observing and analyzing, have brought to its solution qualifications unrivalled in any previous age; and if we may judge from the greater warmth displayed in discussions ordinarily conducted with the calmness of judges, and not with the passion of pleaders, it might seem after all as if the great problem of our being, of the true nobility of our blood, of our descent from heaven on earth, though unconnected with anything that is commonly called practical, have still retained a charm of their own—a charm that will never lose its power on the mind and on the heart of man.

"Now however much the frontiers of the animal kingdom have been pushed forward, so that at one time the line of demarcation between animal and man seemed to depend on a mere fold in the brain, there is *one* barrier which no one has yet ventured to touch—the barrier of language. If therefore, the science of language gives us an insight into that which, by common consent, distinguishes man from all other living beings; if it establishes a frontier between man and the brute, which can never be removed, it would seem to possess at the present moment peculiar claims on the attention of all who, while watching with sincere admiration the progress of comparative physiology, yet consider it their duty to enter their manly protest against a revival of the shallow theories of Lord Monboddo."

Perhaps this passage does not appear inopportunely in view of some speculations that have been suggested by the recent work of Du Chaillu —descriptions of the Gorilla! Mr. Müller adds, as we believe correctly, that, "language, the living and speaking witness of history, was never cross-examined by the student of history, was never made to disclose its secrets until questioned and so to say brought back to itself by the genius of a Humboldt, Bopp, Grimm, Bunsen and others," and "if you consider that whatever view we take of the origin of language nothing new has ever been added to the substance of language, that all its changes have been changes of form, that no new root has ever been invented by later generations, as little as one single element has been added to the material world in which we live, and that in one sense, and in a very just sense, we may be said to handle the very words which issued from the mouth of the Son of God, when he gave names to all cattle and to the fowls of the air, and to every beast of the field, you will see that the science of language has claims on your attention, such as few sciences can rival or excel."

According to Mr. Müller every science has three marked stages; the empirical—the classificatory—and the theoretical. These three stages have suggested the principal division of Mr. Müller's book. The second of these he divides again into the genealogical and morphological classification of languages. Under these latter heads he considers the constituent elements of language, and passes in review, so far as practicable in lectures of this nature, the different classes of roots which he divides into the *predicative* and the *demonstrative*. Mr. Müller's remarks upon the root AR the source of the word Aryan, which he traces "in its wanderings from language to language" (page 239, and post) afford an illustration of his acumen. Our author examines also several of the roots in the three great families of languages—the Aryan, the Semitic and the Turanic languages, and he has added to his work genealogical tables of these three groups, dividing the latter into the northern and southern divisions of the Turanic. In these tables the living and the dead languages are specified.

Mr. Müller asserts the generally received view—that the whole framework of grammar had become settled before the separation of the Aryan family, and thus the broad outlines of grammar are the same in Sanskrit, Greek, Latin, and Gothic, and that it is purely to phonetic corruption, that must be attributed apparent differences. Hence the history of all the Aryan languages is a progress of decay. Mr. Müller's familiarity with the science of language at its present stage of development entitle his views upon the "common origin of language" to a brief notice.

Mr. M. very properly contends that the problem of the common origin of languages has no necessary connection with the problem of the common origin of the *races*. The two questions are independent of each other. Mr. Müller divides the problem of the origin of language into two parts, the *formal* and the *material*, and insists that the three distinct forms, the *radical*, the *terminational*, and the *inflectional*, can be reconciled with "the admission of the common origin of human speech." He admits however that the question is still an open one. In view of the light, as yet thrown upon it, he thinks the problem may be thus properly

stated—"If you wish to assert that language had various beginnings you must prove it IMPOSSIBLE that language could have had a common origin." Without admitting the soundness of all the conclusions to which the historico-analytical school of some eminent German philologists have arrived, it is surely not going too far to say that no such *impossibility* has ever yet been established with respect to the Aryan and Semitic languages—and this is a great point in favor of the advocates of the common origin of language. We do not understand Mr. Müller however as going any farther on this question than the above statement of the problem which we have given in his own words. To leave the question in this position is, we think, to leave it at the point to which science has brought it. Any statement beyond this, in favor of the common origin of language, we believe, rather partakes of exaggeration. The further solution of the problem, belongs to the future of the still *young* "science of language."

Mr. Müller's review of Adam Smith's and Leibnitz's opposite views, as to the formation of thought and language, is written from an impartial and philosophical point of view. Indeed the whole work gives evidence of a true spirit of inquiry. Frequent reference is made by Mr. Müller to the writings of other investigators, and a well merited tribute paid to Mr. Marsh's first volume of lectures upon the English language. We fully agree with him in thinking "that if inductive reasoning is worth anything, we are justified in believing that what has been proved to be true on a large scale, and in cases where it was least expected, is true with regard to language," and "that the science of language leads up to that highest summit from whence we see into the very dawn of man's life; and where the words which we have heard so often from the days of our childhood, 'And the whole earth was of one language and of one speech,' assume a meaning more natural, more intelligible, more convincing than they ever had before."

8. *A Manual of Elementary Geometrical Drawing, involving Three Dimensions.* Designed for use in High Schools, Academies, Engineering Schools, &c., and for the Self-instruction of Inventors, Artisans, &c.; by S. EDWARD WARREN, C.E., Professor of Descriptive Geometry and Geometrical Drawing in the Rensselaer Polytechnic Institute. 12mo. John Wiley, New York.—We are glad to perceive that our teachers and artisans are beginning to recognize the importance of the study and practice of geometrical drawing, and we trust that it will at no distant day hold a prominent place in the courses of study of all our educational institutions. The present elementary work is a valuable contribution toward this desirable end. It is sufficiently comprehensive in its scope for the purposes for which it is designed; and is at the same time minute in its detailed explanations and directions. The subject is treated of under the several heads of—Elementary Projections—Details of Construction in Masonry, Wood and Metal—Rudimentary Exercises in Shades and Shadows—Isometrical Drawing—and Elementary Structural Drawing. While the general plan is scientific without being unnecessarily complex, the special topics are discussed in a simple and lucid manner. It may be mentioned, as an additional recommendation of the work, that valuable rudimentary instruction is incidentally conveyed in it, in the arts of construction.

9. *New Theorems, Tables, and Diagrams, for the Computation of Earth-work;* by JOHN WARNER, A.M., Mining and Mechanical Engineer; Author of Studies in Organic Morphology. 8vo. J. B. Lippincott & Co., Philadelphia.—The author of this elaborate work, in presenting to the public his new theorems, &c., has at the same time furnished students of engineering, and practical engineers, with a systematic treatise on the computation of earth-work. It is divided into two parts. In Part I, styled "A Practical Treatise," the processes of computation, for the various cases that may occur, are minutely detailed and exemplified. A general scheme of all the possible varieties of work, in excavation or embankment, is set forth, and illustrated by an admirable set of lithographic plates, "taken from models made expressly for the purpose."

Two general methods of computation are given; "by Transverse Ground-Slopes," and by "Centre and Side Heights." The computations are greatly facilitated by the use of a new set of tables constructed by the author. Scales are also furnished, to expedite calculations for approximate determinations. The rules and tables are derived from formulæ investigated by the author in Part II. The hyperbolic paraboloid is adopted as the form of ground-surface between two cross-sections of the ground to be excavated or embanked. The new formulæ, investigated upon this hypothesis, are shown to be equivalent to the Prismoidal formula, which Professor Gillespie has proved to hold good in this form of ground-surface.

Where the cross-section of the ground is level, the extended tables of McNeil and others, afford much the readiest means of determining the content of earth-work; provided the assumed width of road-bed and side-slopes are to be found in the tables. But in all cases of irregular cutting or filling, the methods and tables of the present work will materially facilitate the computations. Still it must be admitted that there is an air of complexity about the detail of the preparation of the elements to be used in the calculations, that may restrain many engineers from adopting these new methods. We are disposed to think that if an outline of the author's theory had been presented at the outset, his processes of calculation would be more readily apprehended and more easily retained and applied. A distinct theoretical conception frees one, in a considerable degree, from the necessity of burthening the memory with formal rules, and ensures greater certainty in computations.

PROC. BOSTON SOC. NAT. HIST. (continued from p. 160, vol. xxxii) 1861. Vol. viii. —SEPTEMBER.—162, New species of Microscopical Organisms, chiefly from the River Para; *Loring W. Bailey*, Cambridge, Mass.—169, Ores of Gold and Silver from Sierra Nevada, Pike's Peak and Sonora; *A. A. Hayes.*—171, Native Copper, pseudomorph of? *F. Alger.*—172, On the occurrence of Silver and Gold in the Rocky Mountains and California; *J. Marcou.*—173, Note concerning the Cocoanut Pearl; *John Bacon.*—178, Notice of some North American species of Pieris; *Samuel H. Scudder.*—185, A catalogue of the Koninck library; presented by *Prof. Agassiz.*—188, Descriptions of new Cretaceous Fossils from Texas; *B. F. Shumard.* —OCTOBER.—206, Siliceous Urinary Calculi; *John Bacon.*—NOVEMBER.—212, Catalogue of the Minerals containing Cerium; *Wm. Sharswood*—217, Presentation of Bones of Gorilla from West Equatorial Africa; *Dr. J. H. Otis.*—219, Notice of the genus Selandria; *Edward Norton.*—223, Descriptions of several of Harris's named Tenthredinidæ; *Edward Norton.*